THE

Journal of Electricity, Power and Gas

WITH WHICH IS INCORPORATED

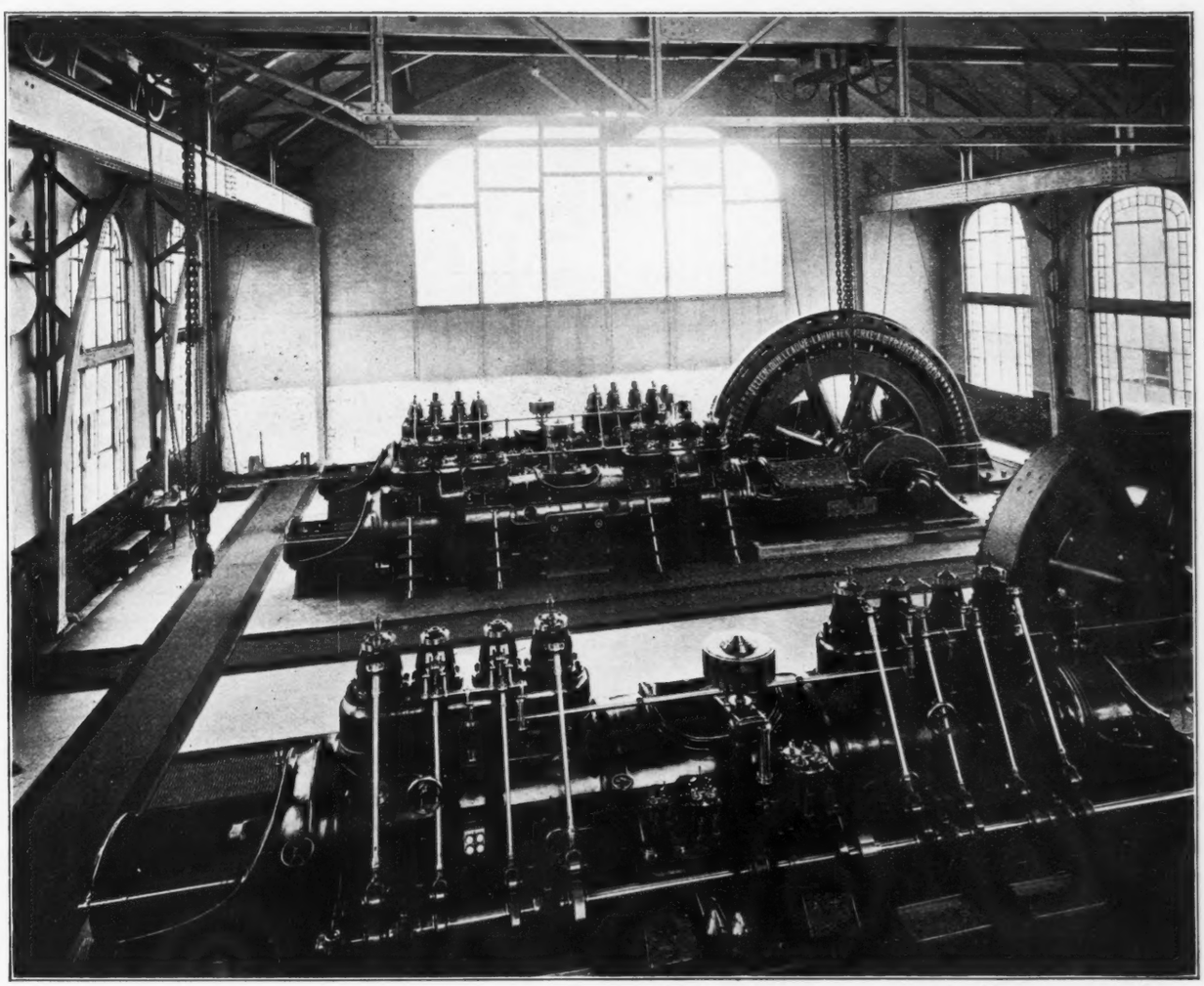
The Engineers' Architects' and Builders' News

VOLUME XVII. SAN FRANCISCO, CAL., DECEMBER 8, 1906 No. 23

Gas Engine Driven Electrical Units

Many of the large iron and steel plants recently constructed in Europe and America, are now equipped with electrical central power stations in which the prime movers are high-power gas engines, using waste blast furnace gases as a fuel. Even the older iron and steel works of both continents have many of them been similarly equipped as the throughout the mines and utilizing coke oven gases which would otherwise be wasted at coal mines where coke is produced.

The accompanying illustration shows the details of construction and method of operation of high-power gas engines driving electrical generators at the government mines at



TANDEM AND TWIN TANDEM GAS ENGINES AT THE POWER PLANT OF THE GOVERNMENT MINES AT HEINITZ, GERMANY.

new ones using direct connected alternators directly coupled to single-acting and double-acting gas engines of the twin and tandem types.

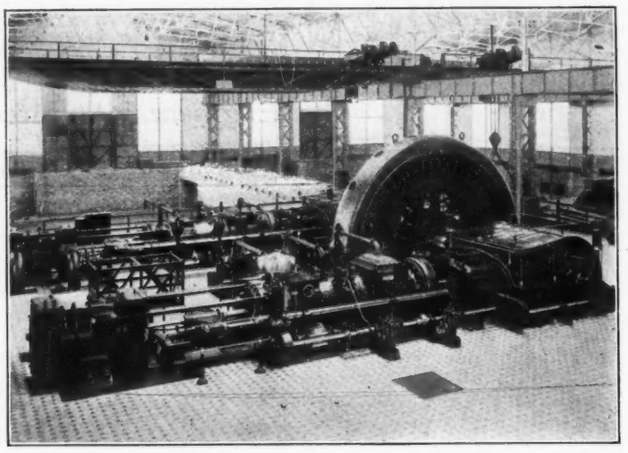
In various mining districts the high-power gas engine has also been utilized to advantage in central stations generating electric power for distributing current to motors

Heinitz, Germany. The illustration and drawing show direct connected double-acting gas engines of 700 horse power capacity of the tandem and twin-tandem construction of Ehrhardt & Sehmer, G. M. B. H. of the Machinenfabrik Schliefmuhle, near Saarbrucken, Germany. These gas engines were installed for the Kgl. Birgenspeken VII, at Heinitz, and are

working with coke oven gas of about 500 Btu. per cubic foot, operating continuously 24 hours in the day, and 365 days in the year, the engine noted in the foreground having operated for nearly a year, so far, without stopping.

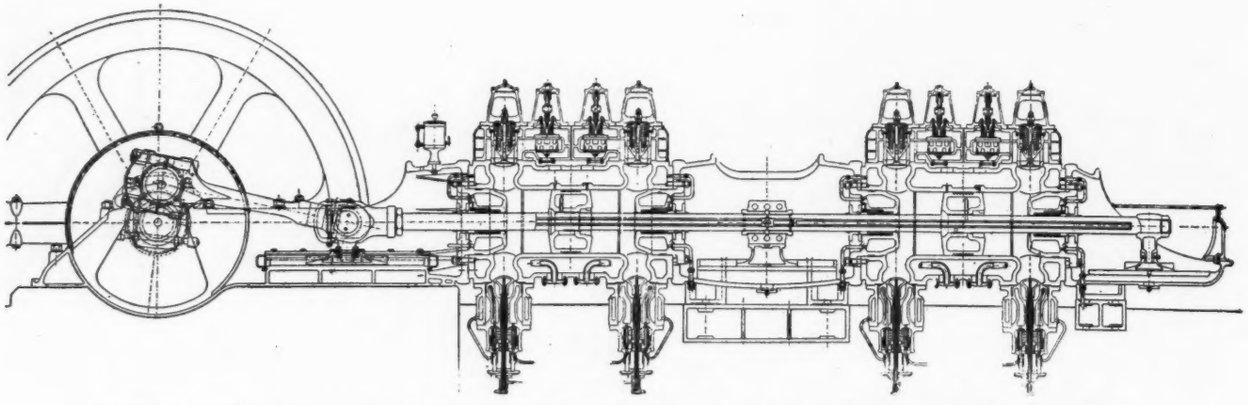
The four-cylinder twin-tandem unit noted in the background has a capacity of 1200 horse power and supplies an alternating current, the generators working in parallel, both the gas engine driven alternators and the steam driven generators.

There has recently been placed in operation in the power house of the Cargo Fleet Iron works at South Bank, England, a 525 horse power double-acting blast furnace gas engine of the four-cycle type, with two cylinders in tandem and direcently coupled to a continuous current electric generator. This engine has cylinders about 251 inches in diameter and a stroke of 29½ inches. It will carry a maximum load of 600 brake horse power and operates at a normal speed of 150 revolutions a minute. With a maximum load of 600 horse power the mean pressure in the engine is said to be over 70 pounds per square inch, assuming an efficiency of



HIGH POWER GAS ENGINE AND ALTERNATOR BUILT AT MASCHMEIBAN-ACTIEN-GESELLSCHAFT OF ASCHERSLEBEN, GERMANY.

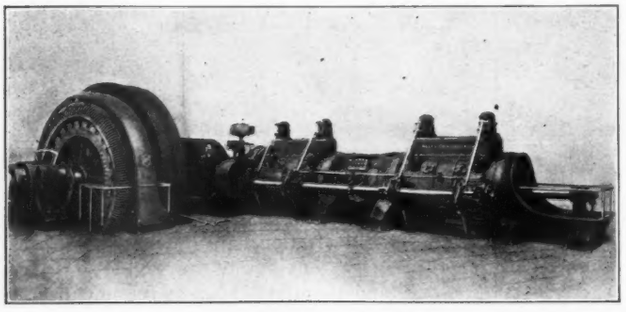
minute, with a stroke of a trifle less than 44 inches and cylinders measuring between 37 and 38 inches in diameter.



DOUBLE-ACTING 700-HORSEPOWER TANDEM GAS ENGINE AT THE GOVERNMENT MINES AT HEINITZ.

82 per cent. and taking into consideration the diameter of the piston rod.

Besides operating on waste blast furnace gases with great economy these engines as well as other foreign and American types of internal cumbustion engines are now being extensively used, driven by Mond gas as well as from other forms of gas producers. One of these engines has recently been installed at Olbury, at the plant of Albright & Wilson developing 1300 horse power and operating on Mond gas. This engine has a speed of 105 revolutions per



ALLIS-CHALMERS' TANDEM HIGH POWER GAS ENGINE AND ALTERNATOR.

In America many high-power gas engines are now being installed driving not only direct current machines but also alternators at the power houses of large manufacturing plants using producer gas and natural gas and also an iron and steel works using waste blast furnace gases as well as at mining plants using coke oven gases. The accompanying illustration shows a large tandem gas engine direct connected to a revolving field alternator of the Allis-Chalmers type recently installed at the Crystal City plant of the Pittsburg Plate Glass Company, while the other illustration shows three 600 horse power two-cycle, double-acting Koerting gas engines direct connected to alternators running in parallel. These engines are operated on natural gas and were constructed and installed by the De La Vergne Machine Company of New York. Similar engines to these, but of the twin construction, have been installed at the main power plant of the Lackawanna Steel Plant at Buffalo, operating direct connected continuous current generators as well as revolving field alternators, these engines having a capacity of 1,000 horse power each.

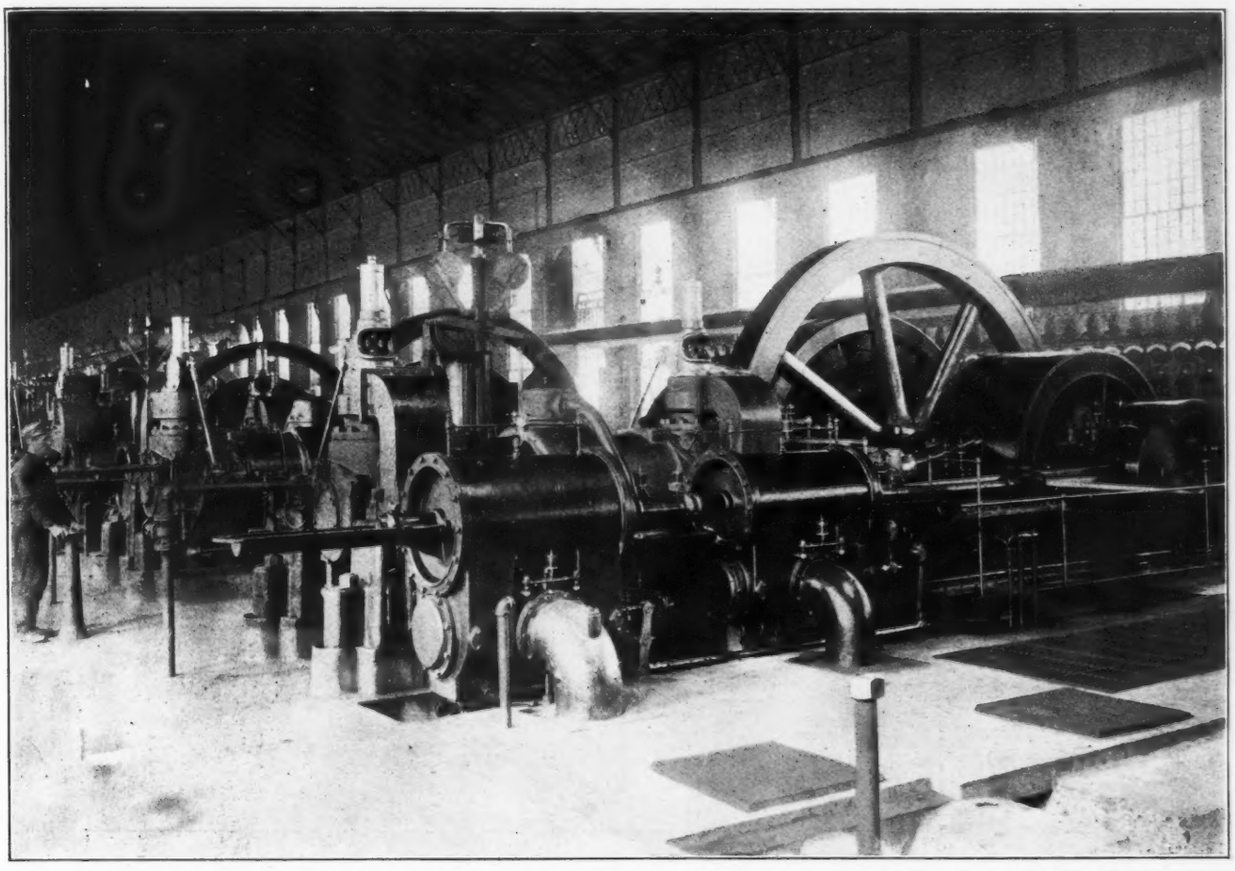
The electrical power station of the Lackawanna Steel plant is also shown. This contains 8 units of 1,000 horse

power each, all driven by waste furnace gases. In another power house at the same plant there are six 2,000 horse power Koerting blowing gas engines, making the total capacity of the gas engine installation 40,000 horse power.

In a number of the German iron and steel works twin engines are also utilized instead of tandem engines. One of these 600 horse power blast furnace gas twin engines is shown in the accompanying illustration, directly coupled to a revolving field alternator built by the Allgemeine Elecktricitates Gesellschaft of Berlin. This twin gas engine unit was installed at the electrical generating station of the Friedenshutte at Morganrath, O. S., by the Gasmotorenfabrik Deutz of Deutz, near Cologne, Germany.

Gutehoffnungshutte, the latter engines being directly coupled to a revolving field alternator of the three-phase type, constructed at the Allgemeine Elektricitats Gesellschaft, Berlin.

Another illustration shows a German high-power gas engine, direct connected to an alternating current generator for service in an iron and steel plant. An 800 horse power unit was installed for the Phonix A.-G. In Laar, near Ruhrort, Germany, by the Vereinigte-Maschinenfabrik Augsburg und Maschinenbau Gesellschaft Nurnburg, A. G., of the twin-tandem, double-acting type. A similar high-power, twin double-acting engine has been constructed by the Naschinenbau Actien Gesellschaft at Aschersleben, Germany, and in Belgium and France a great many large engines have



1000-HORSEPOWER KOERTING GAS ENGINE IN LACKAWANNA STEEL COMPANY, BUFFALO, NEW YORK.

In some instances four cylinders are utilized for increasing the power of a single unit instead of placing the cylinders in tandem. A number of these large engines have been recently constructed in America for use in California for railway power stations as auxiliaries to hydro-electric stations. The Snow Pump Works at Buffalo have constructed a number of four-cylinder engines to be direct connected to alternators for the above purpose, each having a capacity of over 6,000 horse power.

One of these four-cylinder engines of 2,000 horse power capacity was installed at the electric power plant of the iron and steel works at Horde, I. W., in Germany, and another of 1,000 horse power at the Oberhausen plant of the

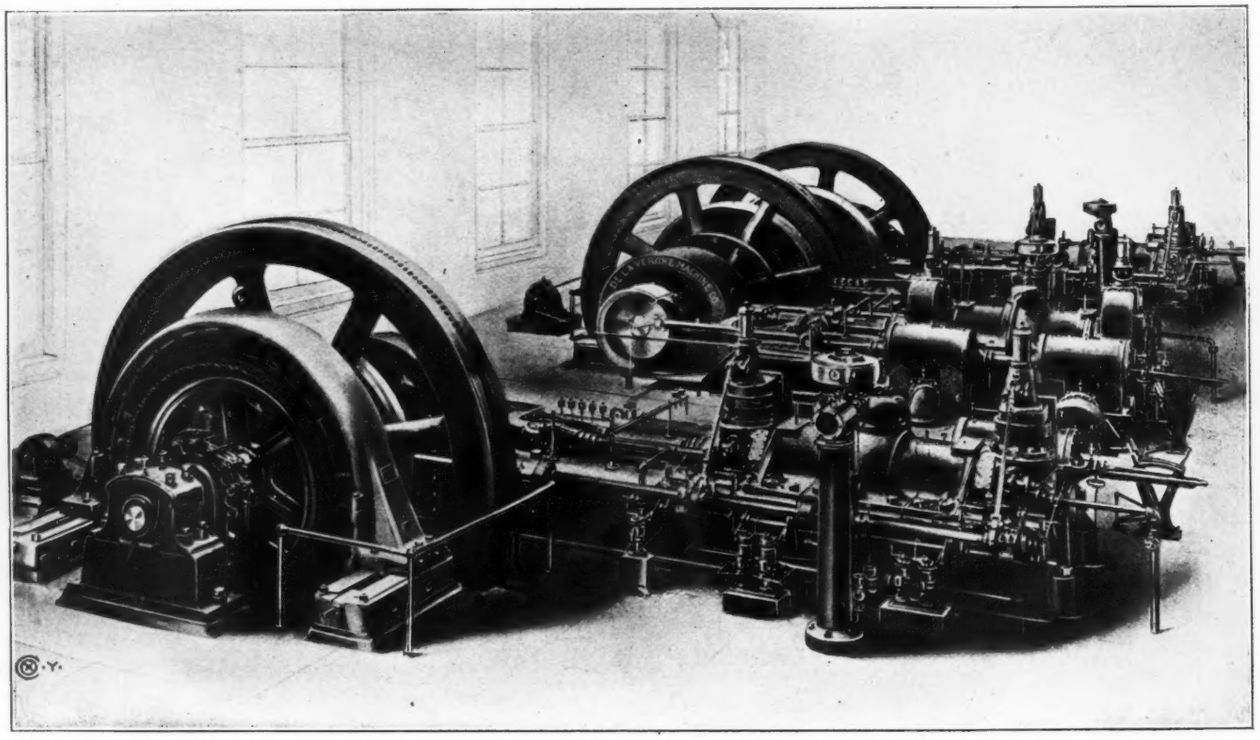
been built of from 250 horse power to 1,200 horse power for each cylinder, arranged in tandem and twin construction for increasing the output of each unit. A 250 horse power tandem engine was constructed by Schneider, of Creosote, France, for the Societe des Hauts-Fourneaux et Fonderies de Ponta-Mousson. The cylinders of these engines are 600 millimeters in diameter, with a stroke of 800 millimeters, while the speed is 150 revolutions per minute. Another similar engine of very much larger capacity, having an output of 1,200 horse power, was constructed by Schneider & Chie for the works at Goeff at MM. de Wendel.

Among the well-known high-power gas engine builders in Europe should be mentioned the Societe Anonyme John

Cockrill, of Seraing, who is constructing double-acting high-power gas engines, using waste blast furnace gases, both double-acting and single-acting on a four-cycle principle, with ten-twin as well as tandem constructed for obtaining large units. These engines are built on the Delmare-Debouttebille-Corcerill system, and are said to have given wonderful results in iron and steel works in Europe.

There is every reason to believe that the high-power gas engine has passed the experimental stage and will now be utilized more extensively than ever throughout the world for utilizing waste blast furnace gases, as well as the waste gases from coke ovens, also when natural gas is available. The wonderful development of the gas producer during the past few years has also opened a field for the internal combustion engine in electric central power stations that was heretofore held exclusively by the steam turbine. The ease with which the gas engine can be started and its immediate readiness for service makes it particularly desirable in electrical central power stations for taking care of the peak of the load.

There has just been installed at the power house of the Herder Bergwerks und Huttenverein at Horde in Westfalen, a two thousand horse power (2,000 H.P.) double-acting Deutz tandem blast furnace gas engine of more than passing interest, as shown in the accompanying illustrations, figures 11 and 12, the former view showing the exhaust side and the flywheel alternating current generator of the Siemens-Schuckertwerke, of Nurnberg, while the latter view shows the valve gear side of this 2,000 horse power engine. This large double-acting engine has a stroke of 1,300 Mm., the pistons having a diameter of 1,100 Mm., while the speed of the engine is normally 95 revolutions per minute. There is little doubt but that the high-power gas engine is coming power for steel plant service.



THREE 600-HORSEPOWER, TWO CYCLE, DOUBLE ACTING KOERTING GAS ENGINES, USING NATURAL GAS AND DIRECT CONNECTED TO ALTERNATORS, RUNNING IN PARALLEL.

SPEED INDICATORS.

Der Elektrotechniker points out that with the aid of a dynamo driven from the axle of a locomotive it would be possible at any time to determine the speed of travel, since an increase in the number of revolutions made by the armature of the dynamo must cause a corresponding rise of voltage. The voltmeter connected with the dynamo should possess two scales, one to indicate the potential of the dynamo, the other showing the corresponding speed of the locomotive per hour. Without doubt the arrangement could be elaborated so as to provide for a continuous record of the speed for reference purposes.

RECOVERING AMMONIA FROM GAS LIQUOR.

Herr H. Warth says that gypsum can replace sulphuric acid in the recovery of ammonia from gas liquor. From gas liquor containing 26 per cent. of ammonia (including 5.2 per cent of ammonium carbonate) the author obtained, by shaking up with burned gypsum (plaster of paris), 80 per cent. of the ammonia as sulphate, and 17 per cent. could be boiled out and caught in sulphuric acid. The use of gypsum thus reduced the amount of sulphuric acid used by 80 per cent. The clear liquor remaining, after treatment with gypsum, can also be treated with sulphate of iron, and sulphate of ammonia can be thus formed without using sulphuric acid.

THE INDUSTRIAL POWER PROBLEM.*

By W. B. Esson, M. Inst. C. E., M. I. E. E.

Everyone is interested, directly or indirectly, in the cost of power, because the lower the price at which it can be obtained, the cheaper can articles of daily use be produced, and the cheaper can they be bought. To us, as engineers, the subject of producing and distributing power at the lowest cost should have special interest, and in this paper an attempt will be made to discuss within a short space the present position in power affairs.

The store of energy which can be drawn upon for power production is existent either in some kind of fuel or in a difference of water level. In this country waterfalls are not numerous, and when they do exist, often owing to the cheapness of fuel, it does not pay to make use of them for power production. Abroad, where waterfalls are largely utilized, fuel is, as a rule, scarce, and there is, in consequence, no competition. Electricity furnishes a means of transmitting to great distances the power derived from water, and accordingly many thousands of horsepower are transmitted by its aid. Though we shall presently have to consider electricity as a means of distributing power, it is proposed in this paper to deal only with cases in which the power production is dependent on some form of fuel. It may be taken that, with rare exceptions, this is the form in which the power problem is presented in this country.

I do not propose to occupy your attention with questions of thermo-dynamics or with considerations regarding the "efficiency" of heat engines, as the term is understood in text-books. The man who takes a strictly commercial view of power matters is generally content to leave theoretical and mathematical considerations to expert constructors. He takes special notice, however, of the money value of the fuel he uses and of the power he gets for it. He judges of the efficiency of the system on the basis of so much paid for so much received, but whether the heat efficiency of the engine per se is high or low is a question which does not trouble him. The most inefficient arrangement, from the scientific point of view, may be properly regarded by him as the most efficient, seeing that he is concerned only with a definition which expresses efficiency in terms of £ s. d.

As regards the power equipment, we take, on the one hand, the cost of fuel, oil, etc., used, the cost of maintenance and labor, and the interest on the outlay, and we take, on the other hand, the number of horsepower hours we obtain for this expenditure. From the figures so obtained we get the cost of the power and a proper basis of comparison for all power plant. If the power has to be afterwards distributed to customers spread over a large area, as from a general power house, part of the cost incurred in delivering to the power user will fall under the head of distribution. If, for distribution, it has to be converted into electricity, the interest on the cost of generators, switch-gear, mains and transformers, together with their maintenance, and the cost of the power wasted in them, have all to be taken into account. We have to convert the power because it has to be utilized, some miles away it may be, from the engine which produces it. Similarly, if the distribution were by means of compressed air, the charges incidental to the installation and maintenance of compressors and mains would have to be reckoned with as well as the cost of the power wasted in them.

Before dealing with the distribution of power from a general powerhouse, let us consider the simple case of a factory having to be furnished with power from power-producing plant located on the premises. We have the choice of steam, gas, or oil engines, and we shall assume that the driving requirements will be met by an engine of 500 brake horsepower. For the more economical distribution of the power throughout the works electricity will be employed, so in each case an electric generator will have to be coupled direct to the engine shaft. This generator will give a maximum of about 470 e.h.p., and, running for 2,800 hours per annum, we will take the electrical output as 1,000,000 e.h.p. hours yearly. Throughout this paper, unless otherwise stated, it will be understood that the power is always delivered in the electrical form.

Beginning with the steam engine, this has in recent years reached such a high state of efficiency that little or nothing in the way of improvement can be looked for in the future. A triple expansion engine of the size mentioned running condensing at 300 revolutions per minute with 150 lbs. pressure, and, say, 100 degs. superheat, will require no more than 14 lbs. of steam per e.h.p. per hour at full load, or 16 lbs. at half load, or working non-condensing 20 lbs. and 24 lbs. respectively. The boilers, steam and exhaust piping, feed pumps, heater, etc., must all be regarded as part and parcel of the power equipment; but as regards boiler efficiency, progress has by no means kept pace with engine efficiency. As a general rule from 20 per cent to 30 per cent of the heat in the fuel cannot be utilized as it passes up the chimney in the waste gases, and is dissipated by radiation from the furnaces and flues. Accordingly, from 70 per cent to 80 per cent only of the heat in the fuel reaches the water, though it is claimed that with water tube boilers, economizer, chain grate stokers and superheaters as much as 85 per cent of the thermal units in a high class coal has been returned in steam. Much attention has been given during the last ten years to the chemistry of combustion, and as a consequence many improvements have been made in furnaces, grates and stoking gear. The object has been not only to obtain more perfect combustion, and to utilize a higher percentage of the fuel value, but to enable cheap bituminous coal to be used with success. As in different type of engines the disparity between the fuel consumption at full and reduced load is not the same, we will take in all cases the mean consumption between full load and half load, and there is no doubt that under this assumption, with the power-producing plant carefully designed throughout, we can easily get when working condensing and with superheat an e. h. p.-hour for every 2.25 lbs. of bituminous slack consumed in the furnaces. This makes ample allowance for the steam used in the auxiliary plant and for the coal used in lighting up, etc. As this class of fuel can be obtained in the manufacturing districts at a cost of 7s. 6d. per ton delivered in the boiler-house, or about 25 lbs. for 1d., it will be seen that for steam plant the cost of an e. h. p., so far as the fuel is concerned, works out at .09 of a penny per hour.

Let us see now what we can do with a gas engine using producer gas. The ordinary town illuminating gas is, of course, out of the question for power production on a large scale, though burnt in an engine of small power running intermittently it may be satisfactory enough. Gas producers are no new thing. They have been used for over half a century to make gas for firing metallurgical furnaces, and as early as 1841 a patent was taken out for a producer constructed on the lines of a blast furnace, which, as you know, is incidentally a producer of large dimensions. Essentially the producer is an enclosed fireplace in which the fuel is burned, not to get maximum heat in the fireplace, but to produce from it the maximum amount of combustible gas. It is only during the last twenty-five years that producer gas has been used as fuel for internal combustion engines. Shortly after the appearance of the Otto engine, Dawson invented a producer which furnished a cheap gas suitable for working it, thus leading the way in the use of this description of fuel for gas engines. Great improvements have been made from time to time in producers for the supply of power gas, but in all the action is the same. Air laden with vapor is passed through a column of solid incandescent fuel, with the ultimate result that the oxygen in the air combines with the carbon in the fuel to form carbon monoxide, and that the

*Address to the Civil and Mechanical Engineers' Society, delivered on October 4, 1906

water vapor is decomposed, its oxygen combining with carbon to form more monoxide and liberating free hydrogen. There are other gases produced, but for the full reactions I must refer you to books on the subject, of which there are several. The gas thus formed passes into vessels, where it is cooled and scrubbed, and thence to the engines. About 1888 M. Benier conceived the idea of letting the working engine regulate the amount of gas produced, the air and vapor supply being drawn into the producer grate by the suction of the piston during the charging stroke. When the producer is operated in this way the product is known as suction gas, and it makes possible a very simple and compact arrangement of producer and engine. The plants at work on this principle are very numerous, the limit as to size being about 500 brake horsepower.

In the early forms of producer for making power gas, only anthracite coal or coke could be used, both of which consist almost wholly of pure carbon. For suction gas these are still the only fuels which can be employed, and, needless to say, they are very expensive as compared with bituminous slack. But the problem of using this latter fuel for power-gas manufacture has been completely solved in the Mond producer, and there are at present working with Mond gas engines giving an aggregate of about 60,000 brake horsepower. When working this system on a large scale, it pays to recover the ammonia which is washed out of the gas before it is suitable for burning in engines.

We can gasify, then, for working our engines, the dearer anthracite or the cheaper slack. Taking the former, which produces gas having a calorific value of about 150 B. Th. U. per cubic foot, the makers of the plant will guarantee that the consumption of anthracite coal in the suction gas installation per hour shall not exceed .8 lb. per. e. h. p. at full load, or 1.2 lb. per e. h. p. at half load. Taking the average of these figures, if we reckon that anthracite peas can be purchased in the manufacturing districts at 24s. per ton, it will be seen that the fuel cost per e. h. p. is about .129 of a penny per hour. If the power happens to be wanted where Scotch anthracite peas can be delivered at 9s. 3d. per ton, as was the case on the occasion of the trials at the Highland and Agricultural Society's Glasgow show in 1905, the figure will of course be much lower.

Dealing now with slack, we will assume that this can be delivered at a cost of 7s. 6d. per ton at the works The Mond gas made from it has a calorific value of about 150 B. Th. U. per cubic foot. A good engine will give an e. h. p. for every 75 cubic feet of gas consumed per hour, and as the gasification of a ton of slack produces about 150,000 cubic feet of gas, calculation shows that the cost per e. h. p. per hour for fuel amounts at full load to about .045d. At half load this becomes .057d., the mean being .051d. As confirming this, the test of a 500-horsepower engine coupled to a generator has shown when running on two-thirds load a consumption of 1.26 lb. of slack per e. h. p. As it does not pay to recover ammonia in a plant of less than 20,000 horsepower, we can in the present instance get no credit on this account.

Coming to oil engines, we shall choose the one invented by Rudolph Diesel as representing the latest advance. This engine works on the Otto cycle like other oil engines, but it differs from them in this, that it is not an explosion engine, and it has no outside flame, hot tube, or electric spark to ignite the fuel charge. This is done as the oil is injected into the cylinders by the heat created in the compression, and as a consequence the indicator card closely resembles that obtained from a steam engine. Oil suitable for Diesel engines now costs in London 42s. 6d. per ton, and carriage added will bring the price up to, say, 45s. The Diesel Engine Company will guarantee that for an engine of the size we are considering the consumption of this oil, which has a calorific value of 18,000 B. Th. U. per lb., shall not exceed .48 lb. per e. h. p. hour at full load, or .56 lb. at half load. Taking the mean between these two figures, the fuel cost for the engine works out at .125d. per e. h. p.

The Mond gas plant, on the assumptions made as regards the cost of fuel per ton, easily distances its competitors in economy. The figures are:

Mond Gas . . . . . .051 of a penny per e.h.p per hour
Suction Gas . . . . . .129 of a penny per e.h.p. per hour
Steam (condensing) . . . .090 of a penny per e.h.p. per hour
Steam (non-condensing) .120 of a penny per e.h.p. per hour
Oil . . . . . .125 of a penny per e.h.p. per hour

These figures have been obtained under usual test conditions, and are just as valuable in giving an indication of what may be expected from the different plants as any figures can be. In taking the consumption in all cases as the mean between full load and half load, allowance has been made for the underloading likely to occur in works, while the fuel wasted in lighting up has been kept in mind. Obviously it depends upon locality as to which plant leads. When we have to use for the steam plant smokeless Welsh coal at double the price of slack, notwithstanding the higher calorific value of the former, the steam plant is then badly beaten by all the others. If we go to the East, where good oil is cheap and bad coal dear, the order of merit is again altered.

I have dealt with the cost of fuel first because it generally constitutes the most important item of running expenses, but it may be that water has also to be paid for. For the steam engine there is some make-up water to be provided for condensing and for boiler feed. For the gas and oil engines there is also make-up wanted for the cylinder cooling water, while for the gas engine there is required water for the producer in addition. For cooling there would require to be circulated round the cylinders of the oil engine about 4 gallons of water per e. h. p. per hour, and round the cylinders of the gas engine about 8 gallons per e. h. p. per hour. The circulating water required for condensation in the steam engine would be about 45 gallons per e. h. p. per hour, and if we assume that there will be lost in evaporation in the cooling towers 3 per cent of the circulating water, this means that a total make-up of 60 gallons, 120 gallons and 630 gallons is required per hour for the oil, gas and steam engines respectively. As regards the water entering the gas producer, this would amount to one-eighth gallon per e. h. p. per hour, which means that rather over one ton of water has to be sucked or blown into the producer for every ton of coal gasified. Then there is the water for cooling and washing the gas, which amounts to 1½ gallons per e. h. p. Necessarily, if the water has to be paid for, it must be taken into account before an exact estimate of the running costs can be arrived at.

In the matter of cylinder lubricant, the steam engine has some advantage, though otherwise the cost of oil is the same. As regards maintenance, many people have the impression that a gas engine requires to have spent on it a much larger amount than does a steam engine. No doubt experience in the past has given encouragement to this view, for engines of large size have only been of recent design, and, like all other new things, they had some troublous times to go through. But the progress made in their design and construction has been remarkably rapid, and some of the most talented engineers are giving their whole time to effecting improvements. When it is remembered that the absence of auxiliary machinery constitutes one of the features of gas and oil plants, it will be realized that, as time goes on, the maintenance cost of these is likely to fall below that on steam plant. In the wages for attendance there is no difference to speak of. Obviously, as compared with steam plant, there is with gas plant about half the amount of fuel to be dealt with, while in working the oil plant is by far the cleanest.

Summing up the running charges for the various plants we have the following:

	Mond Gas	Suction Gas	Steam (Cond.)	Steam (Non-cond.)	Oil
	d	*d*	*d*	*d*	*d*
Fuel	.051	.129	.090	.120	.125
Oil, Water and Stores	.030	.030	.025	.026	.025
Wages	.070	.070	.070	.070	.065
Maintenance and Repairs	.075	.070	.070	.068	.065
Works Cost	.226	.299	.255	.284	.280

The capital which would be expended on the various plants, including the electric generator and main switchboard, but excluding everything outside the powerhouse, is set out as below:

Mond Gas	Suction Gas	Steam (Condensing)	Steam (Non-condensing)	Oil
£6,710	£5,150	£5,400	£4,900	£6,850

These estimates are made up from firm tenders, but as the completed cost would depend to some extent upon where the plant is installed, they must be taken as approximate only.

Adding to the figures of works cost, for interest on the capital outlay and depreciation, 10 per cent per annum, we have on the basis of 1,000,000 e. h. p. hours per annum, to charge each e. h. p. hour with an amount as under:

	Mond Gas	Suction Gas	Steam (Cond.)	Steam (Non-cond.)	Oil
	d	*d*	*d*	*d*	*d*
Works Cost	.226	.299	.255	.284	.280
Cap. Charges	.161	.124	.130	.118	.164
Total Cost	.387	.423	.385	.402	.444

From these figures it will be seen that when any considerable amount of power is required, it can be produced on the consumers' premises at a cost between .387d. and .444d. per e. h. p. hour, according to the plant employed. In getting out these costs the simplest case of one generator has been taken, which, of course, makes the capital cost lower than if the generating portion of the plant were split into two units, each of one-half the size. The object in dividing the plant would be to secure economy in steam consumption in the case of underloading, while incidentally the danger of a complete shut-down of the power plant would be removed. With the whole of the works supplied from one powerhouse, it is certainly advisable to have two sets of generating units. How the figures are modified by this variation you can study at your leisure. Suffice it to say that the capital charges are increased by 15 per cent for steam, 18 per cent for Mond gas, 22 per cent for suction gas and 25 per cent for oil. The lowest cost is .4 per e. h. p. hour, and in no case is a halfpenny exceeded. The question is, Can the companies who undertake to deliver power from a general powerhouse beat this?

Let us consider the circumstances affecting supply of power from a general powerhouse, premising at the outset that electricity furnishes the only means by which such distribution can be successfully carried out. Within their own sphere, pressure-water and pressure-air are capable of rendering most important service, but the sphere of both is necessarily limited, and for general distribution electricity has at present no serious competitor. The price at which the power can be profitably sold is, of course, influenced very largely by the expenditure on the power-producing plant. The difference between the cost of generation and distribution and the amount paid by the consumers for power, constitutes the gross profit on the undertaking, and if the business is to be profitable this must be sufficient to pay administration charges and interest on capital, while making ample contribution to a depreciation fund. It is manifest that, other things being equal, the less the outlay per horsepower the less need be the difference between the prime cost and the cost to consumers, and the cheaper, therefore, will be the supply.

The amount which should be set aside to meet renewals—or, in other words, to form a depreciation fund—has been a matter of some controversy. Though looked after most carefully, and though maintained in a state of first-class repair, machinery must necessarily wear out some day. It is to provide against this evil day that a depreciation fund must be built up, the theory being that the actual value of the machinery at any particular time, plus the amount standing to the credit of the fund, shall together be equal to the original value of the machinery on the day on which it was set to work.

When a loan for electricity works is granted to a local authority under the sanction of the local government board, the latter is guided by the principle that the loan shall be repaid by the time the life of the machinery, etc., comes to an end. The plant includes buildings and foundations, which may last for 100 years or more; boilers, which wear out in about 20 years; and engines and generators, the life of which lies between these extremes. Lumping these and all the other items of an undertaking together we get an equivalent of from 25 years to 30 years for the whole, and the contribution to the depreciation fund is regulated in accordance with these figures. Put shortly, it is assumed that in this period the plant will have been completely worn out, and that its value will have depreciated to zero, but by that time the fund available for renewals will have reached an amount equal to the original value of the plant.

In principal there is no difference between accumulating a fund to purchase new plant by the time the existing plant is worn out and accumulating a fund to return, at the expiry of a lease, the capital sunk in a building. It may be said with perfect truth that the object of the depreciation fund is to make provision against the termination of the machinery's lease of life. Payments to an assurance company in the shape of annual premiums equal to 2½ per cent per annum on the sum advanced will have accumulated to the full value of the sum in about 26 years, and it may be taken, therefore, that an all-round allowance of 2½ per cent on the capital outlay will constitute sufficient provision for depreciation in the case of power-generating works. Separate policies could be taken out for different sections of the plant, according to the length of their life; but this is a detail. What is intended to be shown here is that 2½ per cent on the whole capital constitutes, under proper conditions, a sufficient amount to set aside for renewals, while it would not be wise to allow less. The amount allowed by the London Supply Companies for last year averaged just over 2 per cent.

We will take it, then, that 2½ per cent on the capital outlay represents a fair annual contribution to depreciation, and it will be assumed that, when the undertaking has reached its ultimate capacity, there is the same amount of share and loan capital. Calculating on a dividend to shareholders of 10 per cent per annum, and on interest to debenture holders at 5 per cent, this amounts to paying on the whole capital interest at the rate of 7½ per cent, and with 2½ per cent for depreciation, the annual obligation in respect of capital amounts to 10 per cent. As a rule shareholders do not get 10 per cent, that's of course. But an estimate giving scope to the consulting engineers' imagination is found to be very useful for getting money in. The number of incidents which occur to prevent prospective dividends from being realized is perfectly appalling, and if the price to be charged to the power users is fixed at such a figure as

will return a prospective 10 per cent to cover interest and depreciation, I am sure it will be found none too high in the end.

The percentage charges in respect of capital being taken as above, the amount actually assignable to each horsepower-hour depends, of course, upon the amount of capital invested and on the number of horsepower-hours sold. The expenditure on each horsepower of plant capacity depends upon many conditions. Beginning with the site on which the works are erected, the difference between land values in different localities is enormous. Some way outside a town land may be purchased for £2000 or less an acre, while in a densely populated area it may be £200,000 an acre—that is, one hundred times as much. Assuming that land is purchased right out, it is evident that we have in the circumstance of locality a factor which makes a considerable difference in the capital cost of the undertaking. It is also evident that whether the site is freehold or leasehold, if it is desired to supply power cheaply, the powerhouse must be built on cheap land.

The next thing influencing capital expenditure is the cost of the buildings in which the power generating plant is housed. The character of these is necessarily affected by the site, and it is obvious, therefore, that if we are to get down to the lowest cost, the site must be chosen where regard for appearance has not to be studied, but where the only thing which need be kept in mind is the object for which the buildings are put up. The power engineer takes the view that the buildings merely constitute a covering for his machinery, and a structure in steel and concrete or in steel and corrugated iron will serve his purpose just as well as the handsomest building that could be erected. For architectural features he cares little, but he cares enormously about capital outlay.

The last and most important factor influencing the outlay is the cost of the generating machinery and equipment. If steam turbines are used the cost per horsepower installed is less for large generating sets than for small ones and the capital cost with regard to plant capacity is correspondingly reduced. In addition to the saving on the sets themselves, as these become larger the cost per horsepower in foundations, steam pipes, switching gear, and all that appertains to the generating plant goes down. Working on a large scale makes large sets possible, and as these take up much less space for the power installed, the buildings can be made relatively smaller and the capital cost reduced all round. With respect to fuel economy, with increase in size the steam used per horsepower per hour diminishes, and at partial load large sets may actually use less steam for the same power than smaller sets running at full load. There is also economy in labor, as large sets require no more attention in running than small ones.

There are in London no less than sixty-two electricity supply works, the average capacity of each being under 4000 e. h. p. None of these were erected with the object of distributing power. Though incidentally they have come to distribute a large amount, they were really put up to supply current for lighting, and, having been started on a comparatively small scale, they all cost more per horsepower than what is now regarded as a proper figure. Taking all these works, the cost, including buildings, averages out at £38 per e. h. p. installed, some costing more, some less. Roughly it may be taken that the distribution system costs on the average another £32 per e. h. p., making the total capital expenditure £70.

Recently several estimates have been published showing what large powerhouses should cost with turbo-generating plant installed and everything carried out on the most up-to-date lines. The powerhouse of the London County Council at Greenwich will have a capacity of 45,000 e. h. p., and is estimated to cost, when completed, £19.8 per e. h. p. The portion already finished has reciprocating engines, and as the plant will consist of these as well as turbines, it cannot be considered as quite the latest thing in powerhouses. The new powerhouse proposed in their 1905 bill by the County of London Company was to have a capacity of 13,300 e. h. p., and was to cost £14.7 per e. h. p. The Carville powerhouse of the Newcastle-on-Tyne Company has a capacity of 13,000 e. h. p., and cost £12 per e. h. p. The Lots Road powerhouse of the Underground Electric Railways Company, with a capacity of 100,000 e. h. p., is said to have cost £13 per e. h. p. The powerhouse proposed by the Administrative Company's bill of 1905 was to have a capacity of 120,000 e. h. p. and at that rating the cost worked out at about £7 per e. h. p. But there seems to be a special rating for parliamentary committees of which no man has grasped the sense, and, rated in acordance with the usual practice, this figure would probably be nearer £12. The latest figures of all are for the powerhouse proposed to be erected at Battersea according to the London County Council's 1906 bill, which was to have a capacity of 107,000 e. h. p., and was estimated to cost £11.25 per e. h. p. From these figures it looks as if the outlay per e. h. p. for a modern powerhouse can be reduced to about one-third of what now constitutes the average for the London supply stations. As regards the cost of the distributing system, this depends upon many circumstances, such as the number, size and length of feeding and distributing mains, the route they have to take, the number of sub-stations required, etc., all of which vary according to the scheme and the district for which it is devised.

To get at the cost at which power can be supplied to customers, let us assume that we put down a powerhouse having a capacity of 20,000 e. h. p. From the foregoing figures it would appear than £12 per e. h. p. is a fair estimate for the cost of generating plant and buildings, including incidental changes, while the distributing system may also be taken as costing £12 per e. h. p. Of course, to get an exact figure for the latter, one should consider in detail a scheme for some particular locality; but for the general argument the figure seems a fair one, the total for generating and the distributing plant amounting to £24. Needless to say this is a much lower figure than has yet been found possible for the all-round cost of any undertaking. If we assume that the horsepower hours per annum reach 40,000,000, which, taking into account the loss in distributing, corresponds to a load factor of nearly .29, this means that the capital charge to cover interest and depreciation, reckoned at 10 per cent on the outlay, will amount, in respect of each horsepower hour, to .288 of a penny. The capital cost of the powerhouse and distribution system is £480,000. It may interest you to know that in the Newcastle-on-Tyne concern, which has been brought so prominently before our notice, and which supplies the same amount of power, the total capital embarked reaches £1,193,000.

With respect to the running costs, we must give due weight to the figures obtained from existing undertakings; and to the cost of generating there must be added the cost of distribution and the cost of attendance at sub-stations. Then there is the loss in distribution to be reckoned with—first from the powerhoues to the sub-stations, then from the latter to the consumer. Taking everything into account, and with the experience to hand, it would, I consider, be unwise to assume that the cost of generating and distributing could for a powerhouse of this size be brought under ¼d. per horsepower hour sold, and this is taking coal at 7s. 6d. per ton. After works cost come rent, rates and taxes, then directors' fees, cost of administration and all the miscellaneous items which make up the head office charges in the engineering and business departments. As regards rents, rates and taxes, these items vary with the locality, but at .03d. per horsepower hour we are putting them at a low figure. In London the undertaking with the greatest output pays more than four times this. At Newcastle-on-Tyne the figure is about

.07d., and at Manchester and Liverpool it is .10d. Then we have the cost of administration; and here let me say that to find customers for the output of a large power station requires constant and unremitting effort and a staff to correspond. In putting the cost of this last item and the items not yet accounted for at .06d., we have, I consider, got down to bedrock. In the Newcastle-on-Tyne concern, where the amount of power sold is the same, and where the management is particularly energetic in pushing business, the figure reaches no less than .14d. Our cost per e. h. p. is therefore: Generating, .25d.; rent, rates, etc., .03d.; administration, .06d.; capital charges, .288d.; total, .628d. The conclusion is that unless the undertaking can secure an all-round price of about 5/8d. per horsepower hour, it will not, under the conditions we have assumed, pay the dividends it set out to earn, and if it has to supply below this price, the dividend will shrink to correspond. If shareholders would be content with 6 per cent on their investment, and lenders with 4, presuming all our figures are correct, the price might possibly be brought down to 9-16d.

Several of the London undertakings supply power at 3/4d. per e. h. p. hour, and seeing that the total cost of production, excluding capital charges, amounts to something over 1d., it is only natural to wonder how it is done. Well, it is just because they are not power undertakings that they can supply power so cheaply, just because a large portion of the output is sold at a comparatively high price for lighting can the power portion be supplied at a price which carries no administration or capital charge. If the London companies had to sell all their output at power prices they would be bankrupt tomorrow. Their argument against the power bills should have been: "In the absence of our highly remunerative lighting load, you cannot supply power so cheaply as we." Dumping units to fill up the valleys in the load curves is a good thing, but when, owing to the loads overlapping, the generators must be set aside to supply power or lighting, but not both, obviously lighting pays better. At 4d. per unit for lighting and 1d. for power, the machinery, to produce the same revenue, must, when supplying power, run four times as many hours as when supplying light. To produce that revenue, nearly four times the amount of coal and oil is consumed, to say nothing of extra wear and tear, all of which goes to show that for a purely power undertaking to be successful, it must be conceived on a scale such that the capital cost per horsepower is as low as possible, and the running charges are brought down to the irreducible minimum.

Though our figures show that it will pay the large consumer better to use home-made power than to purchase companies' power, there are thousands of small consumers, whose power plant is generally of the poorest, to whom a cheap supply from the companies must prove an inestimable boon. It is, of course, not surprising to find that power can be produced cheaper than can be purchased; indeed, the surprise would be if it were otherwise. When comparing the cost of a new powerhouse with the cost of one of the older ones of the same capacity, the difference is very marked, the former only costing from one-third to one-half of the latter. The reason for this disparity lies not only in the circumstance that the older station was in the first instance equipped with small sets, but in the fact that the prices of all power machinery have fallen enormously in the course of the last few years. To equip a station on the old lines would cost very much less today than it originally did; consequently it is necessary to make a distinction between the reduction in cost due to the employment of large turbine sets and the reduction due to the general fall in price. Now the manufacturer who generates his own power can take full advantage of the low prices for plant, and can erect suitable buildings very cheaply. It will be seen from our figures that there is not much difference in cost per horsepower between the plant for the large powerhouse and the plant for the smaller installation, the advantage due to the employment of large generating sets in the former being counterbalanced by the extreme simplicity of the latter. Again, for an isolated plant there is no general distribution system, so the total cost of small plant per horsepower falls much below that of the large powerhouse. The interest chargeable in respect of the cost of supply mains may, on each horsepower hour supplied by a company, amount to as much or more than the interest chargeable in respect of the generating plant, and this the man who has his own installation saves. Finally, he need not charge himself for securing his own business; consequently administration charges do not figure in the accounts.

Though it may pay to generate the power on site, considered from the purely investment point of view, the margin is not large, and if the companies can come within reasonable distance of the price I have mentioned they will be sure to secure a goodly number of large consumers. The reason is that to compete with the power companies the equipment in the factory must be of the highest efficiency, and to get up-to-date equipment the power user would have to spend money. That, needless to say, is precisely what he doesn't want to do, and often he hasn't the money lying by to spend. As a rule a manufacturer will do anything rather than put down hard cash to improve his plant, and the companies, knowing this, must be ready to put it down for him. He may know that his power plant is old and inefficient, that years ago it should have been thrown on the scrap heap, and yet he will hesitate. Trade may be uncertain, times may be bad, and he feels that when money is spent on new plant it is irrevocably sunk whether trade revives or not. There is a good deal to be said for his view, and here is the companies' opportunity for coming in. The manufacturer can be shown that he will save money by purchasing power in the form of electricity, and the companies are willing to let him have motor equipment on rental. A customer is then secured who feels that he has not sunk money in the expectation of a boom, but has got the benefit of cheap power, and is paying for it only in proportion to the business he is doing.

The Power Gas Corporation has been good enough to hand me a complete estimate for a power station of 20,000 e. h. p. equipped with gas engines and Mond gas plant. Eight engines are proposed, each giving 2500 horsepower, and provision is made for recovering the ammonia as a byproduct from the gas producers. It may be said that gas engines much larger than the above are in satisfactory work, so there is nothing speculative about the undertaking. In a week or two a 2000 horsepower engine will be set to work in this country, and in America the largest engine yet made, giving 4500 horsepower, is working regularly and satisfactorily with natural gas. The tender for the complete powerhouse is £256,000, which works out at £12.8 per e. h. p., or about the same as a steam powerhouse. As regards running costs I have not been able yet to check the corporation's figures, but one circumstance stands out in the boldest relief, and that is that the cost of the fuel is wholly recovered in the value of the ammonia sulphate obtained from its gasification. Whether there is any set-off against this in the form of extra labor or expense in attending to the gas and ammonia plant over that of attending to an ordinary boilerhouse is at present a matter of inquiry, but that only about half the weight of fuel requires to be dealt with has been already pointed out. I have the greatest confidence in the future of this principle by which waste is eliminated and valuable byproduct recovered. There is a wide field for its application, and it will no doubt influence to a large extent future development in the domain of power distribution.

I have said that as a means of distributing power, electricity has no competitor, but recently efforts have been made to distribute, not power, but fuel in the form of Mond gas, which may suit the requirements of some manufacturers better than power delivered electrically. The gas can be used either

in gas engines for driving purposes or for heating, and the South Staffordshire Mond Gas Company is the pioneer of this development. The company has laid about 30 miles of pipes and delivers gas between six miles and seven miles from the generating house. During the first six months of this year there were delivered from the mains of the company to customers over 1,700,000,000 cubic feet, at an average price of rather under 2d. per 1000. Taking 80 feet per e. h. p. hour as the consumption for the usual size of gas engine met with, this means that the fuel cost amounts to .16 of 1d. per e. h. p. hour. This is about what suction gas costs when generated on site, labor and capital charges in respect of the plant being included. I learn that the aggregate capacity of all the Mond gas plants at work gives an equivalent of about 240,000 b. h. p.; but as three-fourths of the gas is used for heating metallurgical furnaces and for other purposes where heat is required, it appears that power will not form the company's chief source of revenue. In districts where heat as well as power is wanted, the system has every chance of success; there are no serious engineering difficulties in the way, and it must be remembered that gas distribution on a large scale for lighting is already an existing thing. Possibly it will surprise you to hear that if all the gas distributed from the eight stations of the London Gas Light and Coke Company were used for power purposes, it would represent 450,000 horsepower of gas engines running continuously for 3000 hours per annum. The combined output of the sixty-two electrical stations in London represents under 60,000 horsepower for the same period.

Another advance in the direction of distributing fuel gas is proposed for Cumberland. The idea is to erect power-houses at Marysport, Workington and Cleaton Moor, and arrangements have been made to utilize the waste gases from the blast furnaces of the three greatest ironworks. Part of the gas will be used in engines, for generating electricity, and the remainder will be distributed. It is estimated that gas representing 60,000 horsepower is being dissipated continously from these furnaces. Think of it! and reflect also on the enormous waste of a similar kind going on all over the country from both blast furnaces and coke ovens.

With these observations my remarks on power topics must come to an end. I have endeavored in this address to let you know how matters stand and how things are tending, though it must be observed that an undertaking that manages to live by power alone, at present lives only on paper. But that there will be established in London at no distant date an undertaking for the supply of power only, appears to be pretty certain. A great many promises have been made as to the price at which power can be supplied, but the figures on which they are based are necessarily somewhat hypothetical, and are, I fear, in some cases illusory. That is, perhaps, unavoidable, for the reason that the power-houses proposed differ both in magnitude and design from those which have furnished our experience. Consequently it is not known for certain how the price will come out, and the figures which have been given have certainly not been pessimistic. It has been suggested that the power-house should not be in London at all, but that the power should be transmitted to London from the coalfields. The proper kind of fuel to use, say the advocates of this scheme is cheap slack, the proper place to use it is at the pit's mouth, and the proper way to use it is to gasify it in Mond producers and then burn the product in gas engines. An ammonia recovery plant would constitute part of the equipment; and it must be admitted that such a scheme has for the power engineer great fascination. Whether it would be commercially successful is another matter however, and one which I will not discuss this evening.

The modern factory is usually, perhaps naturally, consideerd one of the products of modern civilization and progress. It would bemore true to say that modern civilization is a product of the modern factory; analysis will show that this is true. Modern civilization is pre-eminent in the material needs which mankind possesses in these modern times. In former generations every man was his own house builder, his own weaver and spinner, his own brick mason, his own coach builder and harness-maker, and in fact practically all of the functions which are now carried on by manufacture were then carried on by the individual, each man's manufacture to support his own uses. Since the product of this miniature factory was small the appliances were exceedingly crude, and consequently the time required to produce the given amount of material was excessive. Modern arrangements have superseded these. Now one man or one group of men devote their entire time, attention and energies, for instance, to the manufacture of a certain variety of cloth. All the appliances that ingenuity can devise have been provided to enable this group of men to produce the maximum quantity and the best quality of this particular variety of cloth with a minimum expenditure of energy. What is the result? Where one man in former generations could produce only perhaps a few yards of cloth per day, with modern methods the same amount of human labor can produce thousands. Another man, instead of weaving cloth, spins yarn, another makes wagons and coaches; another harness; and so it goes, each man devotes himself to one specific thing,with the result that the efficiency is increased almost incredibly. By efficiency I mean the net result which can be produced by a certain amount of human labor. Labor is really the only available product that mankind has; no material is of any value unless labor has been performed upon it. Modern civilization is because the efficiency of this element of labor has been increased to a point almost infinitely beyond that which existed in former times; in other words, by modern methods a given amount of labor produces infinitely larger results than in former times. A weaver, therefore, is enabled to expend his labor and energy in the produce of thousands of others who are working on their particular specialty, and thus he is enabled to have a total which is almost incredibly beyond the total which our forefathers could possess, because the total labor of the present day working at so much higher an efficiency is enabled to produce such vastly increased results over the same labor in former times. I think, therefore, that I can say without fear of contradiction, that modern civilization is the result rather than the cause of the modern factory.

Whatever, therefore, increases the efficiency of the modern factory must necessarily make for progress. There is, I believe, no single element that has entered into the increased efficiency of modern methods so much as the use of electricity. Perhaps I should exclude from this generalization the use of the steam engine in all its ramifications. The steam engine is a producer of power, whereas electricity is simply a transmitted power.

There are three classes of men who are responsible for the progress of human knowledge and for the advance of mankind in general. In the first of these classes we have the genius who lays down the fundamental laws of science. This class includes, for instance, such men as Sir Isaac Newton, who first enunciated the law of universal gravitation; such men as Galileo, Kepler, Copernicus, who laid down the laws governing the heavenly bodies; such men as Carnot, Watt, and Rankin, who enunciated the laws of modern thermodynamics. The geniuses in the electrical field come to mind easily because with great wisdom we have named the electrical units from them: Ohm, Ampere, Volta, Galvani, Faraday, Maxwell, Weber, Oersted; all of these men contributed their labors to the electrical science and contributed with such success that their names have been perpetuated by calling after them the units which the electrical engineer has to deal with. These men too have labored in the interests of pure science, without the hope or expectation for material reward for their labors in this direction.

In the second class of men who are responsible for modern progress are those who, starting with the fundamental laws, have applied them by invention to practical uses. The number of men in this class is exceedingly large; it embraces such men as Edison, Bell, Howe. Here in Niagara Falls there are some men of world-wide fame who may be included in this class—Hall, the inventor of the process for the production of aluminium, and Atchison, whose work in electric furnaces has placed a new agent in the hands of the world.

The third class that I consider responsible for modern progress is the men who advanced the capital necessary to carry on manufacturing activities of modern times. It is this class that probably has been best paid in the material things of the world for their participation in modern progress. A number of instances of such men come to mind readily: Carnegie, who invested in ideas for making steel and has becomes many times a millionaire; Cyrus W. Field, who invested in the idea of the trans-Atlantic cable; financiers who have invested their capital here in Niagara Falls in the idea of electric power transmission. These are only a few of the examples of this third class who are responsible for the advance of civilization by having sufficient faith to put their money into modern ideas.

All of these classes of men have been particularly active in the field of electricity, and instances come to our minds in this field with particular ease because the development in this field has been so rapid. It is only a little over a hundred years since the electric fiuid has had a name. It has been considerably less than a hundred years since the first intelligence was transmitted by electricity. It is only within the last twenty-five years, however, that rapid progress has really begun in this line. It is only within that time that the art of lighting by electricity and the art of generating it for mechanical power has been perfected.

Electricity has become an agent for the advancement of civilization in two ways—first, it has produced methods of doing things which were done by other means formerly, but doing them in a much quicker and more efficient manner. For instance, formerly the power of a steam engine was transmitted to the lathe by means of belts and shafting, which means were both expensive and inefficient, cumbersome and dangerous. Go into the modern factory and you see no belts or shafting with its continual wear and nerv-racking hum. In its place you will see a few innocent wires which carry the electricity from the generating point, situated to suit convenience, directly to the piece of apparatus that it is wished to operate. As for lighting, it has done away with the expensive and dangerous oil and gas and has substituted a brilliant, easily controlled, inexpensive source of light. Many other instances could be named in which electricity, although it has accomplished nothing new, has enabled us to accomplish those things with much greater efficiency.

Second, electricity produces things which, without it, would be absolutely impossible. The whole art of electroplating, for instance, depends absolutely upon its use. The art of dissociation of compounds by the electric current and their recombination into other compounds is due to its use. For instance, the process of aluminium production which is carried on so extensively here in this city. The process of decomposition of salt and recombining its elements into other compounds is due absolutely to its use. The electric furnace is but another tool which, used by such men as Atchison and others who are familiar to you, has become an agent to produce results absolutely unattainable by other means and will become no man knows how useful an agent.

THE ADVENT OF SINGLE-PHASE ELECTRIC TRACTION.

It is often claimed by railway engineers that electricity cannot haul their trains as cheaply as steam, and that therefore steam is better, and will not be replaced. Let us allow that the assumption as to cost is true for the moment—is the deduction correct? It is generally true that engineering problems reduce themselves ultimately to questions of cost, and unless a process or undertaking will pay, it is no use to advocate its introduction. But there are many ways of paying besides the direct one, and it would probably be as easy to show a record of increasing costs in the history of the world's progress as to point to the record of reduced costs. To take two instances closely connected with our subject. Is railway carriage cheaper than canal carriage, which it replaced? Or, again, is incandescent electric lighting cheaper than gas? In such cases the public is willing to pay higher for the superior service, though it may not always be easy to define in what the superiority consists. It sometimes appears to be hardly more than a matter of fashion, but there are usually subsidiary advantages which account for the change, though these may not be easy to value in money. There are other cases where more expensive accommodation is provided to meet competition, though the public will pay no more for better service; for example, the luxurious modern railway carriages.

Fortunately, electric traction is not one ot these sources of expense which the railways are driven into adopting, though they do not increase their profits, nor will its adoption depend merely on fashion.

Why, then, is the new power so surely coming? Because it will increase the earning capacity of the line. This has been the experience with tramways from the beginning, and in more recent times with railways.

The following examples will illustrate the usual results of electrification: In 1901 the trams on the west side of London were electrified, and in three years, while the mileage was increased four fold, the traffic increased seven and a half fold.

The Manhattan line in New York was electrified the same year. In the first year after electrification the traffic increased 50 per cent, and the costs of working fell from 55.79 per cent to 41.2 per cent of the gross receipts.

The Milan-Gallarate-Varese line was also electrified in 1901, and in three years the number of passengers carried increased 170 per cent.

On the North-Eastern Railway, at Newcastle, the traffic on the electric lines has increased 25 per cent, and the receipts have gone up from £129,000 to £151,000 while the costs have only risen from £42,761 to £47,779.

With these facts before us it is obvious that electricity cannot be condemned merely on the question of cost of power.

I have so far assumed that the cost of electric power is actually greater than that of steam power. This may sometimes be the case in England, where the electric power has to be generated by steam; but there are also many cases where the reverse is true.

Numerous attempts have been made to arrive at a general comparison between the costs of electricity and steam, but these are all unsatisfactory and misleading, since the results depend almost entirely on the assumption made with regard to the nature of the service to be provided, the most economicall conditions for steam being widely different from those for electricity. In almost all cases when electric working is introduced, the service is altered so that no simple basis remains for a comparison of cost. I do not, therefore, purpose to base any part of my argument on a possible direct saving in the cost of power. What then are the special merits of electricity, and how does electric working increase the earning capacity of the line?

The advantages of electrification may conveniently be classed under three heads, though there is no hard and fast line between them:

1. Improvements affecting the comfort of the passengers.
2. Improvements relating to the train service.
3. Improvements relating to the working and capacity of the line.

Under the first two headings we may consider the advantages to the passengers, and under the third the advantages to the railway company.

1. The improvements affecting their comfort which passengers obtain from electrification are: purer air, less dirt, more light and warmth, and better lighting of suburban stations. It is not necessary to enlarge on the attraction of these.

2. The improvements in the train service which the passengers obtain are: faster trains and a more frequent service, and several others depending on modified methods of working the traffic, which will be referred to later. The attraction of fast trains need not be insisted on, and the importance of the frequency of the service is quite as great. In all the cases I have quoted the conversion to electric working has been accompanied by a great increase in the frequency of the service. On the North-Eastern Railway, for instance, the number of trains was doubled; on the Milan line the car mileage was increased two and a half times the first year; on a line between Hartford and New Britain the traffic trebled in four months after electrification, the number of trains having increased four times. There can be no doubt that the success of electric trams is largely due to the frequency of the service, and the more nearly the railway service on suburban lines can approach this the more popular it will be. Thus electrification provides the public with a faster, more frequent and more comfortable service of trains.

3. Turning now to the railway companies' point of view, let us consider how electrification affects the working and capacity of the line.

The higher speed and more frequent service which are possible on electric lines are due to the rapid acceleration which can be attained, and the saving in shunting at the termini possible with self-propelled trains. The decrease of time lost in stopping and starting at stations enables the trains to be spaced closer together; and this, combined with the higher average speed, may increase the carrying capacity of the line between 50 and 100 per cent. That electrification is the only way in which the carrying capacity of the suburban lines can be increased is pointed out in the report of the Royal Commission on London Traffic. On the Lancashine and Yorkshire line from Liverpool to Southport the number of trains was increased from 36 to 65 per day in each direction, concerning which the chairman stated that it "would have been absolutely impossible under the old conditions." The effect of this increased carrying capacity on the earning power of the line need hardly be pointed out. As the chairman of the North-Eastern Railway said: "By running smaller trains, and more of them, they were able to serve the public better and make better profit themselves."

On main lines electrification will enable the railway companies to provide express trains running at much higher speed than the present ones, and also to give a more frequent service, and to do more in the direction of through carriages. These advantages are due to the unlimited supply of power available at the train, and to the subdivision of the power along the train, which does away with the heavy concentrated load of the locomotive, a serious difficulty on light roads and weak bridges. The number of motors is proportional to the length of the train, and the speed is independent of the fireman's ability to keep steam and of the state of the weather.

The important trials at Zossen have shown what can be done in the direction of very high speeds. In England we are fortunate in already possessing lines sufficiently well built to enable trains of suitable design to run at much higher speeds than the present steam trains. Many of our main lines could carry trains running at an average speed of 80 miles an hour instead of sometimes under 60 miles per hour; indeed, it is probable that higher speeds still could be used with perfect safety, and that the speed of our express trains could be increased 50 per cent. Such speeds would, of course, fall far short of those attained at Zossen, which reached 124 miles per hour; but they would be a very great increase on anything we have at present. Moreover, it would be easier to run a frequent service of small trains at this high speed than to run on occasional longer train; thus we should have the ideal condition from the travelers' point of view.

The advantages of the multiple-unit composition of the trains are many. In the first place, the saving of shunting at the termini is of immense importance; it affects both the size of the station and the cost and speed of working the trains. In the next place, it enables remarshaling of trains at junctions and the handling of through carriages to be very much simplified and quickened. Finally, it enables the size of the trains to be frequently varied, so as to correspond to the requirements, thus saving empty car mileage. The working time table of the North-Eastern Railway bears interesting testimony to the advantage which can be taken in practice of this power of altering the composition of the trains.

Subsidiary advantages of electrification depend on the supply of power all along the line. This may be usefully applied to working the signals, fog signals, switches, turntables, pumps, capstans, lifts and other apparatus. It is also probable that a good deal of troublesome shunting in warehouses and sheds might be done by electric locomotives where steam locomotives are inadmissible owing to the danger of fire and the nuisance of smoke.

The absence of smoke will reduce the costs of the painting and cleaning of stations and ironwork in tunnels, etc. The troubles due to smoke in tunnels, particularly in the approaches to stations in towns, may alone be enough to make the introduction of electric working advisable; it was on this account, I believe, that electricity was first introduced in the great New York Central station.

In addition to the advantages so far enumerated, electrification opens the way to new methods of working; and if the full benefits are to be reaped from the change of power, these new possibilities must not be neglected.

As I have already said, electrification is not simply a cheaper or more economical method of hauling trains. Electrical engineers do not say to the railway companies, "We can replace steam locomotives by electric locomotives and haul your trains at less cost." What we do say is, that if you electrify your lines they will pay better. The electrification will enable you to make your service much more popular; it will attract far more traffic, and it will enable you to carry that traffic which you could not do by the present means. The success of the tramways and the extraordinary growth of the habit of travel in the population where facilities of the right sort have been provided, show conclusively that there is an enormous traffic ready to be carried if it is properly catered for.

GAS MANTLES.

A Copenhagen company has introduced a method of making mantles so that these present no folds at their upper parts and do not require sewing with the aid of the sewing machine, the needle of which often cuts the fibres. The top of the mantle is gripped against a ribbed tube by a correspondingly shaped pair of pincers. This narrows the top of the mantle, forming ribbing without folds; and the top is strengthened with a strip of tull passed round. The free end of the mantle and the strip of tull, above the pincers, are pushed down with a little round stick into the ribbed utbe; the pincers are released and the mantle removed. A stitch through the tull at the top is then sufficient to hold all fast.—From The Gas World.

OIL-ELECTRIC BOATS.

The indirect method of driving automobiles by electric motors which receive their current from a generator driven by a petrol engine has proved to have many advantages, and a similar arrangement is now being tried both in this country and in Europe for propelling cars on railways. A recent number of the Electrical Review (New York) comments editorially on the extension of this principle to ship propulsion. Economy of fuel, of space and of weight is an essential to success in marine engineering, so that the oil engine which does away with boilers and which gives a remarkably high thermal efficiency offers a possibility of making an important development in marine engineering if it can be applied satisfactorily. Unfortunately, these engines are generally irreversible, and they do not submit readily to speed control. Moreover, they cannot be started under load. These features are, however, essential in marine work, so that to apply the oil engine to propelling boats requires the introduction of some system of transmission between the engine and propeller which will make up for the deficiencies of the engine; and here electrical transmission has stepped in, for by attaching a generator to the engine and a motor to the propeller shaft the desired flexibility is obtained.

This plan is, of course, not perfect, for the introduction of the two new mechanisms offsets, in part at least, the displacing of the boilers. But the high efficiency of the oil engine still remains, and even when coupled with the necessary electrical losses may give a resultant efficiency still above that obtainable with the steam engine. And the system brings with it other advantages not obtainable in any other way. The engine may run at a constant speed, for which it is best suited, while the speed of the propeller may be changed at will. Moreover, the control of the propeller speed may be transferred from the engine room to the pilot house, and thus valuable seconds saved when navigating difficult waters. There is probably also some gain resulting from the elimination of one human link in the chain from pilot to propeller.

The system just referred to has been tried in a small way abroad, where it is giving some degree of satisfaction; but a recent modification of it has been made which partially eliminates the defects of the other. The new system was patented recently in this country by C. Del Proporto, but it has been undergoing trial for a year past on Lake Geneva, in Switzerland, and at St. Petersburg. The principal changes made are the reduction of the size of the generator and motor and the providing of a mechanical coupling between engine and propeller shafts. Since the flexibility of the electrical system is of most service when maneuvering, which is usually done at a decreased speed, the full output of the generator and motor are not then required. This work may therefore be done by a generator and motor of reduced size. In the new system they are rated at one-half the output of the engine, which will be found ample for such purposes. For proceeding at full speed, however, the electrical system possesses no particular advantage, and may, in fact, be cut out and the propeller directly attached to the engine shaft. This is accomplished by means of a mechanical coupling, as the engine is placed so as to allow this to be done. Under these conditions the generator and motor are cut out, their armatures acting merely as flywheels, and all electrical losses are avoided. The arrangement has the further advantage of reducing the weight of the electrical apparatus. The two vessels which are now being tried have apparently given goods accounts of themselves. Although these equipments are small, it is not impossible to install large engine-power on shipboard by coupling two or more engines to one shaft, and, if necessary, by using two or three propeller shafts.

Developments in this direction will be watched with interest by marine engineers, for if an oil engine may be used for ship propulsion important advantages will be gained in other ways. Oil is not only a more concentrated fuel than coal, but is more easily handled, and its adoption would do away with the large corps of firemen now found necessary as all the fuel could be handled by means of pumps. Further, the increased thermal efficiency of the engine, together with the more concentrated type of fuel, would increase considerably the useful range of the vessel.

THE PRACTICAL VALUE OF THEORETICAL SCIENCE.

The delving into the mysteries of science is looked upon by the average layman as the innocent but fruitless diversion of a certain class of peculiarly constituted men. It is an error, especially common in this country, to belittle, if not entirely to overlook the intrinsic value of the work of scientific investigators whose labors are almost entirely confined to the discovery of new facts and theories. The entire structure of modern manufacturing is founded upon the results of purely theoretical work; and upon the further development of such research must depend the future advancement of industry.

The great corporations have found that it is profitable to employ scientific investigators; but either the inducement offered, or the restrictions imposed, seem opposed to the highest achievements of scientific discovery in this manner. In fact, scientific discovery cannot be made to order with any more success than poetry can be written to order; the great scientific discoveries have been made, and are likely to continue to be made, by individuals working out their own particular ideas in their own free way.

The theory of the production of light and the various phenomena connected with its production and use form one of the most abstruse subjects of pure science. On many points in the theory scientists are by no means in general accord. Just why the chemicals forming the Welsbach gas mantle should afford so much more efficient light radiation than many other substances, such for example as the carbon, is one of these disputed points.

The discovery of new scientific facts, which have resulted in the recent improvements in means of generating light, are due almost entirely to European scientists, particularly to those of Germany and Austria. The American mind seems to have lost, if indeed it ever possessed, the faculty of continued application to minute details which constitutes the chief requisite for successful scientific investigation. The American is too impatient for results, especially for results which can be expressed in dollars and cents, to allow of his following a particular line of research for its scientific value only.—The Illuminating Engineer.

AMMONIA IN STORAGE BATTERIES.

Ammonia is one of the most objectionable impurities that can be introduced into the electrolyte in storage battery working. A new test for this impurity has recently been put to use. The black precipitate or coloration, due to the production of nitrogen iodide by the action of iodine on ammonia, may serve as a delicate test for the presence of the latter and for its determination calorimetrically. The direct use of iodine is not convenient, since the reaction between iodine and ammonia does not take place when only traces of ammonia are present. But if iodine chloride be employed in the presence of a base, the reaction is very delicate and affords an appreciable coloration with only one part of ammonia per 500,000. The best method of applying the test consists in producing the iodine chloride in the liquid under test by the action of an alkili hypochlorite upon potassium iodide. The liquid should be approximately neutral.

The JOURNAL OF ELECTRICITY POWER AND GAS
WHICH IS INCORPORATED
The Engineers' Architects' and Builders' News

Published Weekly by
The Journal of Electricity Publishing Company
304 Atlas Building, San Francisco.

Yearly subscription, $2.50. Single copies, 10 cts. Foreign subscription, $3.50 Subscriptions cannot be begun with back numbers. Manuscripts submitted must be accompanied by postage to insure return.

Address all communications and make all remittances payable to the Journal of Electricity Publishing Company.

EASTERN AGENCIES:
NEW YORK
CHICAGO
ST. LOUIS

WESTERN AGENCIES:
LOS ANGELES
PORTLAND
SEATTLE

Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," with which is incorporated "The Engineers' Architects' and Builders' News."
Entered as second-class matter at the San Francisco Post Office, August 15, 1899.
Entered as "The Electrical Journal," July, 1895.
Entry changed to "The Journal of Electricity," September, 1895.

VOL. XVII DEC. 8, 1906 No. 23

EDITORIAL.

The Public and the Corporation.

Present conditions in America certainly do not tend to increase the confidence of the people in the public service corporations. Much is heard on all sides regarding the desirability of municipal ownership of systems of transportation, water supply companies, electric light and power plants and telephone installations. The reasons for this general feeling are many, some of which are good, some bad, some based on facts, and some on false premises.

Aside from the national interest in the control of the extensive steam railway systems of the country, as well as the rates charged, and rebates given to large shippers, the most important matters are probably connected with the construction of, and the service given by, the many necessary light and power, street railway, telephone and water supply systems of our great cities.

The great centralization of financial interests, the organization of "holding companies" and the concentration of control in what are usually called "trusts," has undoubtedly made many corporation managers unwisely independent and neglectful of the people's interests. In the end, this independence and real neglect cannot but react upon such companies, and is, if continuously carried out, a serious error, even from the companies' standpoint.

On the other hand, the public gets its information primarily from the newspapers, which, unfortunately, are not only thoroughly unreliable, but publish only a part of the facts of any given case. The people, therefore, except by meagre observation, do not appreciate that these companies have, as a result of reorganization, in practically every instance greatly improved the service, and have expended large sums of money in extensions and betterments, which were made necessary by the abnormal growth of American cities during the past decade.

Yerkes, the great Chicago street railway operator, is quoted as having said that the dividends of a street railway company depend upon the number of "strap hangers." Certainly it does seem at times that the street railway lines of many large cities are not sufficiently supplied with cars, or the rolling stock is not of such character as to give the best service. To any one familiar with the electric railway situation in Southern California, however, it is evident that in that instance at least, the extension of the street railway lines and the character of service given has always anticipated the real demand. The city and its immediate suburbs have undoubtedly been greatly benefited by the excellent service given by the electric street railway lines. It is not always possible, on the other hand, for all street railway companies to consistently carry out this policy, in part at least due to delays which arise in securing the materials of construction and the proper equipments.

Some public service corporations are, by virtue of the character of their service, necessarily monopolies. While it is possible for a city to be supplied with transportation facilities by a number of street railway companies, it is questionable whether a multiplicity of telephone companies could result in a satisfactory telephone service from the user's standpoint. It must be admitted that telephone service is abominably bad in many cases, but it is not true that a number of telephone companies are necessary in order to provide better service.

In the eastern part of the United States, where the conditions are favorable, the municipal water systems have undoubtedly, in the majority of cases, been successfully constructed and operated by the city governments. A careful investigation of the administration of American cities during the past twenty-five years, however, conclusively shows that it would be most unwise to give the politicians, who seem for the most part to control municipal affairs, a firmer grasp upon the public treasury, or enlarge their field of influence. Whenever it is possible to get a business-like, honest and economical administration for a city, and have such administration continue for all time, the municipal ownership of such public service corporations will not only be desirable, but their operation will be financially and in other ways successful.

The United States Civil Service Commission announces an examination on December 12-13, 1906, to secure eligibles from which to make certification to fill a vacancy in the position of miscellaneous piecework computer in the Naval Observatory and other similar vacancies as they may occur in the Naval Observatory. The Department states that miscellaneous computers are paid by the hour, and earn from $800 to $1,000 per annum.

BOOK REVIEW.

"Alternating Current Motors," by A. S. McAllister, Ph. D., 272 pages, 122 illustrations. McGraw Publishing Company, New York. Price, $3.00, net.

In this book the author has presented a treatment of alternating current motors for students who are already somewhat familiar with the fundamental principles of electricity and magnetism, especially of alternating currents. Apparently, there is no royal road to the theory of the induction motor, and a profitable reading of this book requires the same close application and study that is demanded by other books on the same subject. The book includes a discussion of single and polyphase circuits, the induction motor and induction generator, synchronous motors and converters, and commutator motors, which include repulsion and series motors. Both algebraic and graphical methods of analysis are employed, and curves are frequently used to show the characteristics of the particular type of machine under discussion.

TRADE CATALOGUES.

The Benjamin Electric Mfg. Co., which has offices at San Francisco, Chicago and New York, is distributing, under Catalogue No. B-17, an up-to-date 104-page buyer's guide for wireless clusters and lighting specialties. The catalogue is divided into seven parts, devoted respectively to cluster bodies for series or parallel connection; ceiling forms; pendant forms; weatherproof forms; arc-bursts; sockets, plugs, receptacles, show case fixtures, lamp guards, etc.; and exterior and interior fittings, shades and shade-holders, canopies and reflectors. Illustrations are generally distributed throughout.

The Rockwell Engineering Co., 26 Cortlandt St., New York, has recently issued several publications devoted to fuel-oil-burning appliances, furnaces and heating machines for manufacturing purposes. Catalogue F is an eighteen-page booklet describing high and low pressure of oil burners, steam-actuated and belt-driven oil pumping systems, positive and fan pressure blowers, burner plates, tanks and other oil-burning appliances. This catalogue contains many illustrations, as well as tables of dimension and operating data. Seven separate bulletins are devoted to double-chamber metal melting furnaces, pot furnaces for lead and cyanide hardening and for melting soft metals, brazing furnaces, annealing and hardening furnaces, flue-welding furnaces, heating machines for annealing, hardening, coloring, etc., and rivet-heating furnaces. These are suitable for either gas or oil fuel.

"What We Do in Iron and Steel Works Equipment and Ore and Coal Handling Machinery," is the title of a handsomly illustrated booklet just issued by the Wellman-Seaver-Morgan Co., Cleveland, O. By means of an extensive set of photographs, this company shows some of the larger equipments which it has installed in various plants throughout the United States, thus giving a good idea of the character of the work it is prepared to execute in the future. This company manufactures and installs steel works and blast furnace equipment, gas producers, engines, and water turbines, coke oven machinery, ore and coal handling machinery, mining machinery, cranes, etc.

Bulletin No. 4465 of the General Electric Company, Schenectady, N. Y., contains some concise information on the proper selection and location of trolley frogs for different services. In addition, this bulletin contains photographs and list prices of nine different styles of trolley frogs.

The General Electric Company's Bulletin No. 4467 is devoted to The Emergency Straight Air Brake System for operating motor cars singly or in trains. This bulletin describes in detail the action and construction of the motorman's valve and the emergency valve. The details of the governors, compressors and other apparatus have already been described in previous bulletins. The emergency air brake is particularly suitable when a motor car and trailer are operated under unit control.

HARBORS OF CALIFORNIA.

Arrangements have now been completed for the sixth semi-annual meeting of the Counties Committee of The California Promotion Committee, to be held at San Diego, Saturday, December 15. At this meeting the theme of discussion and action will be "The Harbors of California," and papers will be read by prominent men from all parts of the state. Governor George C. Pardee, George A. Knight, William W. Harts, Major, United States Corps of Engineers, Alfonso Afl Tregidgo, president of the California Miners' Association, Judge J. J. Boone of San Diego, George D. Gray of the Lumber Producers' League, O. H. Miller, secretary of the Sacramento Valley Benevolent Association, C. M. Gidney of Santa Barbara, Gilbert B. Morrow of Sonora, Lee C. Gates of Los Angeles, John H. Hartog of Colusa, M. F. Tarpey of Fresno, and others, will make addresses.

STRANGEST CLEAN-UP IN THE HISTORY OF MINING.

Not long ago the Bonanza Basin Gold Dredging Company, operating an Allis-Chalmers gold dredge in the Bonanza Basin, Alaska, reported the finding of a perfect specimen of magnetic iron ore, or lode-stone, in the dredge clean-up.

Although from its unusual size, the specimen referred to was a rather remarkable one to be picked up by the monster dredge, it seems that a still more remarkable clean-up was made recently by this company from the same outfit. In fact, one of the most marvelous ever heard of in mining history.

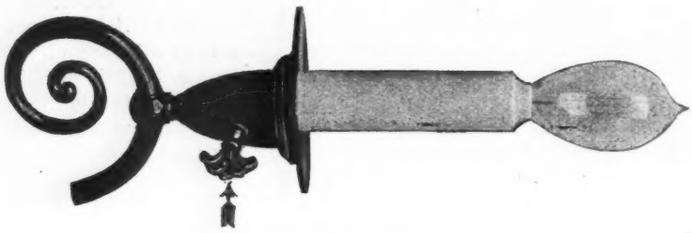
When the long sluice box was opened recently, preparatory to the periodical clean-up, it was found that the bed of the slough which had just been worked, had yielded an assortment of stuff the equal of which has never before been seen in Dawson or elsewhere in the mining regions of the West. The collection disclosed, among other things, two Russian bronze ikons which had probably been carried into the region by Russian explorers many years before the Klondyke was heard of. The ikons were identical with those carried by some of the regiments of the Czar's army in the late Japanese War. Besides the ikons were found eight American pennies, probably thrown into the slough by some prospector in a fit of disgust when he realized that they possessed no purchasing power in the Yukon district. There were also recovered about 100 lbs. of unexploded cartridges, gallons of bullets, many of which had a coating of amalgam which necessitated their treatment for the gold adhering; 120 pounds of nails of all sizes; an alarm clock, a saw set; two Masonic gold charms; an opal with its setting from a broken scarf pin; innumerable pieces of watch chains; knives, forks, keys, locks, native bismuth, cassiterites, stanitos, magnetic cubes, magnetized octohedrons, bushels of black sand and a number of nuggets worth over $10 a piece. piece.

The last item caused some surprise, as it had been generally understood that the gold in the basin was of a fine quality.

The dredge, which is now in winter quarters, has been in operation all summer.

INDUSTRIAL

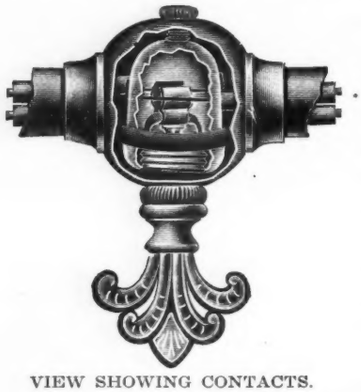
NOVELTIES FOR FIXTURE WORK.



FIXTURE SHOWING SWITCH.

The very general application of electrical apparatus for the illumination of hotels, apartment houses, restaurants and, in fact, all kinds of interiors, has created a demand for a type of fixture that would be easy to install and have the same self-contained features of the present-day gas fixture.

To meet this demand, The Sarco Company, 906 Sixth Avenue, New York City, has created an adaptation of its "Noscrue" key-arm switch, the applications of which may be seen from the accompanying illustrations.



VIEW SHOWING CONTACTS.

By the use of this key-arm switch the work of the fixture fitter is made very easy, and it is possible to make use of a wide variety of decorative forms.

When the "Norcru" key-arm switch is inserted in the chandelier line, it has a place analogous to the gas cock in the gas fixture.

A valuable feature of this key-arm switch lies in its being absolutely screwless. The ends of the wires are passed through terminal bushings, make a long wiping contact with the blades of the key-arm switch. The very small size of the key-arm switch makes it applicable for an elaborate fixture, without in any way detracting from its symmetrical appearance.

CANOPY SWITCH.

The new "Noscru" canopy switch has an especially valuable feature to the chandelier fitter. This canopy switch can be used for any bracket or fixture by simply boring a 5-16-inch hole in the canopy, body or base, pushing two wires through the holes in the porcelain body of the switch, bending them over, replacing the cap and fastening the lock-nut.

The Sarco Company has made up these fancy fixtures in a large variety of forms. The selection is such that a suitable lighting fixture can be secured to satisfy the choicest requirement.

METAL FILAMENT INCANDESCENT LAMP.

The new metal filament electric incandescent lamp, the Osram, has been examined and reported on by the Charlottenburg Physico-Technical Institute. The lamps are now made for 100 to 130 volts, and of 32 and 50 candle-power; larger sizes are to be made afterwards, and next year lamps for 220 volts, from 40 to 200 candle-power, are to appear. The Institute found that for voltages between 100 and 150 the consumption was about 1 watt per Hefner candle, for lamps from 30 to 50 candle-power. The durability is on the average 1,000 hours. The fall off in lighting power was below 3 per cent. in 1,000 hours. The lamp takes direct or alternating current, and lasts equally long with either. Dr. Lux says the Osram behaves singularly like the wolfram lamp, and the general distribution of light by it is much the same as that of a carbon filament lamp. He finds the consumption with 32-candle-power lamps at 110 volts to be 1:08 watts per Hefner candle, and 170 volts the light is equivalent to 156:1 Hefner candles with a consumption at 0:48 watt per Hefner.

The sales department of the Electric Storage Battery Company, of Philadelphia, held their annual convention at the Bellevue-Stratford Hotel, Philadelphia, on October 24th, 25th and 26th. The convention was attended by the managers of the sales offices of the company throughout the United States, the district engineers, and other officers of the company.

Mr. Robert McF. Doble of Colorado Springs, formerly of San Francisco, has been retained as consulting and supervising engineer by Messrs. Curtis & Hine, general managers of the recently organized Central Colorado Power Company, in the development of their large hydro-electric power projects on the Grand River, Colorado.

NATIONAL ELECTRIC SALES.

The National Brake & Electric Company, Milwaukee, Wis., report, among recent orders for generators, the following:

Simmons Mfg. Co., Kenosha, Wis., one 1,000 K. W. engine, type alternator; Union Electric Light & Power Co., St. Louis, Mo., two 500 K. W. three-unit synchronous generator sets, and one 200 K. W. induction motor generator set; Proctor & Gamble (for Staten Island Plant), one 400 K. W. engine type alternator and one 125 K. W. engine type alternator; Hicks Locomotive & Car Works, Chicago, Ill., one 500 K. W. belted alternator; Clymer Power Co., Riegelsville, Pa., one 250 K. W. water-wheel type alternator; U. S. Light & Traction Co., Hobart, Okla., one 250 K. W. engine type alternator, and one 250 K. W. engine type alternator for Sheridan, Wyoming, plant of above company.

A FEW RECENT SALES OF ALLIS-CHALMERS CO.

Among a large number of recent sales made by the steam engine department of Allis-Chalmers Company may be mentioned the following of coast interest:

Ventura County Power Co., Ventura, Cal. ** 16 in. and 32 in. x 36 in. Reynolds' Heavy Duty Tandem Compound Corliss engine, 300 K. W.. Allis-Chalmers generator.

S. H. Harmon Lumber Company, San Francisco, Cal., 22 in. x 42 in. Reynolds' Heavy Duty Corliss engine.

Douglas Improvement Company, Douglas, Ariz., ** 16 in. and 32 in. x 36 in. Reynolds' Vertical Cross Compound Corliss engine, 325 K. W. A1 Allis-Chalmers generator.

American Trading Company, Kobe, Japan, 18 in. x 48 in. Reynolds' Heavy Duty Corliss engine.

Carquinez Brick & Tile Company, San Francisco, Cal., 20 in. x 48 in. Heavy Duty Reynolds' Corliss engine.

STATION OF WESTCHESTER LIGHTING COMPANY.

The Westchester Lighting Company serving a large residence and suburban section extending from Long Island Sound to the Hudson River and from the Borough of the Bronx to Tarrytown, has a modern central station plant at New Rochelle, the principal feature of which is an Allis-Chalmers steam turbine generating unit now being installed. The electrical power generated here, supplying the towns and villages connected to the company's system, is three phase, 60 cycles, 13,200 volts, and is used mainly for lighting purposes. The power house is of steel and brick construction, supplied with an equipment of six water-tube Sterling boilers, 250 H. P. each, in three batteries, and two Babcock & Wilcox boilers of 524 H. P. each, which furnish the steam power for the turbine and engine equipment. Coal is brought up the channel in barges to the company's docks, where it is hoisted and conveyed by automatic coal-handling devices to a bin of large capacity situated outside the power plant. Coal is conveyed from the bin to steel charging cars through chutes, the cars running on tracks directly to the furnace doors in the boiler room.

The main generating units are operated condensing, the reciprocating engines and the new turbine being equipped with jet condensers. The condensing water is taken from Echo bay through a large suction pipe which is connected through a continuous service foot valve. The 1,500 K. W. steam turbine unit is provided with an interesting condenser arrangement.

The new turbine unit has been added to the station equipment to take care of the largely increased demand for current resulting from the increased population of the district. The electrification of the lines of the New York Central and Hudson River Railroad, and of the New York, New Haven and Hartford Railroad, both of which run through the area fed by the Westchester Company, have brought with them a new impetus to the growth of the district.

AN ELECTRICALLY OPERATED RAILWAY IN SWITZERLAND.

One of the recently equipped electric railways in the mountains of Switzerland is the Sernftal-Bahn, connecting Schwanden with Elm, a distance of about eight and three-quarters miles over varying grades, which in some cases exceed 41 per cent. There are sixteen cars operated on this line, usually in short trams consisting of a motor car and a trailer for both passenger and freight service. Each motor car is equipped with two direct-current motors of 65 horse-power each, operating at a line pressure of 800 volts. The motor coaches will each seat thirty passengers, while the trailers can accommodate forty. The freight-conveying trailers are built for a normal load of five tons. The wheel bases for the passenger coaches measure eight feet two inches, and for the freight cars, thirteen feet.

Current for this line is supplied by a hydro-electric plant at Engi-Vorderdorf, which is the second principal station from Schwanden. The hydraulic equipment of this plant consists of two water turbines of 200 horse-power each, operating under a head of 125 feet. The efficiency of these turbines is said to be 68 per cent. at one-quarter load, 85 per cent. at one-half load, 87.6 per cent. at three-quarter load, and 85.5 per cent. at full load. The canal which supplies the water is 164 feet long; the penstock is 1850 feet long and 3 feet 4 inches in diameter. The maximum capacity of this plant is about 500 horse-power.

Continuous current generators are direct connected to the water turbines, and are driven at a speed of 600 revolutions per minute. These machines each have a capacity of 135 K. W. and are of the shunt-wound, eight-pole type. The armatures are 2 feet 6 inches in diameter and 12 inches wide. Each armature has 201 slots, each of which carries two conductors of 12 inches by 2 inches in cross-section.

To take care of the peak of the load and improve the regulation, there is a storage battery installation consisting of 390 cells, each of which will normally supply 200 amperes for one hour.

The overhead trolley wires on this railway are copper conductors having a cross-section of .077 square inches, and are mounted on iron and wooden poles. The feeder cable which runs from the power station, has a cross-section of .1 square inch.

The entire equipment is of European manufacture. The motors and controllers for the cars, and the generators for the power station were built by the Naschinenfabrik Oerlikon at Oerlikon, near Zurich, Switzerland.

The monthly meeting of the Illuminating Engineering Society will be held in the Edison Auditorium, West 27th St., New York City, on Friday, December 14th, at eight o'clock.

A paper will be presented by Dr. C. P. Steinmetz, Schenectady, N. Y., the title of which is to be announced later.

According to an English report, tests of various blast furnace gas power plants showed that the heat empolyed by the engines (most of which are, of course, large units) varies from 8,700 to 13,000 B. T. U. per B. H. P. hour.

News Notes

TELEPHONE AND TELEGRAPH.

Spokane, Wash.—Albert Held, architect, announces that contracts for the Home Telephone Company's building in Spokane will be awarded in December. The building will cost between $60,000 and $70,000. Work is now progressing on the excavating, and the company is actively at work setting poles and otherwise preparing for the establishment of the "girlless" service. President Tucker says the new exchange will be in operation in eight months.

Spokane, Wash.—The Pacific States Telephone and Telegraph Company has made arrangements with the owners of the rural telephone lines at Athena, Ore., to use them in conjunction with its line. In a few days a new switchboard will be installed and both lines connected at one office. As many farmers and business men had perfected an extensive system of rural lines, there was little business left for the Pacific States line save in long distance calls. It is now thought better accommodation can be had and friction obviated.

Spokane, Wash.—The Rocky Mountain Bell Telephone Company is extending its lines. Besides completing the line to Spokane, by which two circuits do the work of three, and almost completing the Bonners Ferry composite line, which may be used for telegraph and telephone purposes, connecting Coeur d'Alene with Iola, Elmira, McArthur, Naples, Moravia and Bonners Ferry, it has begun another line to Harrison by way of Fourth of July canyon. These improvements are expected to greatly facilitate business between these points. The service heretofore has been insufficient to meet the demands.

Bellingham, Wash.—At the annual meeting of the Farmers Phone Co., to be held December 11, a proposition to extend the line to this place will be considered.

Seattle.—The Sunset Telephone Co. was granted permission to erect new poles on Elm street, Dangridge avenue, Post street and Jefferson place.

Wenatchee, Wash.—The Farmers' Telephone line is down between this place and Cashmere.

Grangeville, Idaho—The Pacific States Co. has been making extensive repairs on its line at this place and will soon begin the construction of a new direct metallic copper line to Lewiston.

New Westminster, B. C.—Work has been commenced on the new Grand Trunk Pacific telegraph system near Portage La Prairie.

North Bend, Ore.—A wireless telegraph station will be installed in this city by the Pacific Wireless Telegraph Co.. at a cost of $2,000.

Olympia, Wash.—B. F. Hall and others have formed a company to construct and maintain another rural telephone line along the county to a point near Lacey.

Pullman, Wash.—A temporary consolidation has been made of the Tacoma and Pacific States Telegraph companies at this place.

Stites, Idaho—Dr. Alcom has bought the telephone line belonging to the Farmers' Co-operative line between Lowe and Trimway. The line will be extended to Stites and Green Creek.

Berkeley, Cal.—The ordinance has been passed to print calling for bids on a telephone franchise. The Home Telephone Company is the party interested.

Yreka, Cal.—The Postal Telegraph Company has twenty-one men employed placing new poles between Cole's and Edgewood. The company intends rebuilding its branch line between Edgewood and Yreka.

Spokane.—The contract for the excavation of the building which the Home Telephone Company is to erect on Howard street, near Second, Albert Held, architect.

ELECTRIC RAILWAYS.

Aberdeen, Wash.—A. J. West, one of the directors of the Grays Harbor & Puget Sound Railway Co., states that the line will be built from Grays Harbor to the Sound within the next eight months. The company has increased its capital from $10,000 to $500,000.

Hood River Ore.—The citizens of Mosier have submitted a proposition to the Hood River Electric Light & Power Co. to extend its lines to that place, a distance of six miles.

Boise, Ida.—The Faris-Kel Construction Co. established a camp for a track crew on the Boise & Interurban, three miles from this city.

Cheney, Wash.—Eslick & Hartnett, of Spokane, were awarded the contract for the construction of an electric line from this place to Hayford for about $50,000.

Conconnully, Wash.—An electric railway from Nighthawk to Brewster, by way of Loomis, the Q. S. mines, Conconnully, Alma, Malott and Phin is proposed by A. M. Dewey and associates.

Kent, Wash.—Council granted a franchise to F. G. Chamberlain for an interurban street railway.

Puyallup, Wash.—Articles incorporating the Puyallup Valley Northern Rapid Transit Co. have been filed at Olympia, with a capital stock of $3,000,000. The trustees are: Fred J. Chamberlain, John Mills, F. S. Martin, W. R. Scott, Chas. Fulmer, L. A. Chamberlain of Puyallup, and August Von Boecklin, L. A. Stevenson and H. H. Blackburn of Tacoma. The principal office of the company will be in Puyallup. The purpose is to operate a system of electric interurban railways from Tacoma to Puyallup, Sumner, Auburn, Kent and Seattle.

Sedro-Woolley, Wash.—An interurban company is being organized for the purpose of constructing an electric road from this place to La Conner via Burlington, Avon and West Mount Vernon by A. W. Lyon of San Francisco, C. E. Bingham, A. E. Holland and J. B. Alexander of this place.

San Francisco.—It is reported that a deal had been consummated whereby the United Railroads would take over the entire property of the California street railway system.

Vancouver, Wash.—The Council granted a 50-year franchise to W. H. Moore and L. B. French for an electric railway system.

Oakland, Cal.—The Oakland Traction Company, recently incorporated to take over the Berkeley Traction Company, and the Oakland Traction Consolidated has issued a call for a special meeting of stockholders, to be held January 15th next, to consider the matter of a new $12,000,000 bond issue. The official call for the meeting says: "Said special meeting of the stockholders is called by said board of directors for the object and purpose of considering and voting upon the proposition to create a bonded indebtedness of said corporation to the amount, in the aggregate, of $12,000,000 (a portion of which is to be used in paying and retaining existing bonded indebtedness), and thereby to increase the bonded indebtedness of said corporation up to the amount in the aggregate of $12,000,000 for the purpose of constructing and completing its railroads and paying off and discharging the debts incurred in the construction and completion thereof, with their equipments, and for the purchase of railroads, rolling stock, and other property within the purposes of the said corporation, and to secure the payment of the bonded indebtedness so proposed to be created by mortgage or deed of trust upon all the corporate property and franchises now belonging to the said Oakland Traction Company, or which it may hereafter acquire."

San Francisco.—The annual meeting of stockholders of the Bolinas Bay Oil Company will be held December 11th, at 518 Montgomery street.

San Francisco.—A special meeting of stockholders of the Star Oil Company will be held at 2576 Washington street, on December 5th.

TRANSPORTATION.

San Francisco, Cal.—The Board of Supervisors has unanimously adopted a resolution inviting bids for the sale of a franchise to run for twenty-five years for a street car line on certain streets of the Parkside district, including Nineteenth avenue, as petitioned for by the Parkside Tract Sompany. December 29th is set as the time for receiving bids for the franchise. The line as proposed is to commence at the intersection of Ocean and Corbett avenues, thence running through private property to Nineteenth avenue, thence to W street to Market street, if extended, thence to the Great Highway. Branch lines will also run from W street and the Great Highway, thence to Forty-sixth avenue; also from Twelfth avenue and T street to Thirty-third avenue to V street, to Thirty-fifth avenue, and on Nineteenth avenue from W street to and across H street to the entrance of Golden Gate Park.

Oakland, Cal.—Application for a franchise for a union belt line railroad running from the eastern boundary of the city along the lien of the tidal canal to a point near the foot of Nineteenth avenue has been presented to the committee of the whole of the City Council by the newly organized Union Belt Line Railway Company of Oakland, represented by Attorneq R. M. Fitzgerald. After some discussion it was referred to the Council without recommendation. This action was taken at the request of Attorney Philip M. Walsh, representing the Southern Pacific Company, who informed the members of the committee that he had been assured by Superintendent W. S. Palmer that the Southern Pacific Company has in preparation a plan which, when presented to the Council, would be acceptable to al lparties concerned. Walsh agreed that his plan should be presented to the Board of Supervisors at the next meeting of that body, that both propositions might be considered at the same time.

San Farncisco, Cal.—General Manager Calvin of the Southern Pacific Company says: "We are going to electrize the Alameda mole system. The matter has been under discussion for some time, and yesterday I received orders from the East to go ahead with the work, and also received the approved plan of the work to be done and the style of car to be used. The cost is estimated at $1,126,695. The plan of electrizing will take in all the lines running out from the Alameda mole, which include the narrow gauge line to High street, the Alameda broad gauge through Alameda to Fruitvale and on to Melrose and the Oakland narrow gague line." The type of car to be used is an 84-passenger car, such as is in use on the Columbus, Delaware and Marion line, running out of Columbus, O. The largest passenger coaches in the present steam car local service have a passenger capacity of 64 passengers. The company has already selected a site for the powerhouse on Alameda Point, where the present roundhouse is located. The system to be installed will be the overhead trolley. The work will be commenced as soon as the material is on the ground. The order reached General Manager Calvin Wednesday, and material will have to be secured before work can be started.

Los Angeles, Cal.—In the vicinity of Dayton and Cypress avenues, the St. Louis Car Company of St. Louis, Mo., has purchased 28 acres, and it is said will build car shops in the near future.

Pomona, Cal.—The City Trustees have accepted the $10,000 bond of the Pacific Electric Company, whereby the company is pledged to begin the work of construction of the new electric railway within four months. Work will commence as soon as the Covina line is completed.

Monrovia, Cal.—It is probable that actual grade construction will begin within a month on the Pacific electric line of the Monrovia-Azusa extension. It was reported that the contract had been let for a $100,000 cement bridge across the San Gabriel by the railroad company, but this is now denied.

Sacramento, Cal.—A complete Marconi wireless telegraphy system will, it is said, be installed in this city for transmitting reports of the legislature, which will meet in January. It is expected that instruments will be installed and ready for action by the first of the year. Senator Smith of Los Angeles is interested and stated that it is the intention to install the system in all of the most important ciies and owns on the coast. A plant will be installed at Eureka when the one is being put in at Sacramento.

TRANSMISSION.

Marysville, Cal—The Western Power Company wants bids for furnishing teams, material and machinery for the work now in progress near Oroville. D. A. Viele, of the engineering firm of Viele, Cooper & Blackwell has arrived here and will establish offices at once, from which he will direct the construction of the Western Power Company's power plant at Big Bend. The men at work on the tunnel have made a good start on the entrance to the tunnel and the building of roads. The old tunnel will be enlarged and lined with solid concrete.

City of Mexico, Mexico.—Dante Cusi has applied to the Department of Fomento for concession to use water from the river Cupatizito,State of Michoacan, for motive power for the La Lombardia smelter, in the district of Uruapam.

Sparks, Nev.—W. C. Clapp, General Manager of the Nevada Commonwealth mine at Washoe, left last night for Joplin to purchase machinery to equip the mine with electrical service.

Tonopah, Nev.—The Nevada Electric Power, Mining and Milling Company will expend $400,000 in extending the power line of the company to the Bullfrog mining district, a distance of ninety miles. When the power line is completed the power line and the new mining camps will be supplied with electric power. This includes Tonopah, Goldfield, Manhattan, Silver Peak and Bullfrog.

San Francisco.—A petition for dissolution has been filed in the Superior Court by the Electrical Engineering Company. It is stated that the dissolution of the corporation was decided upon at a meeting of the stockholders on October 13th. The petition sets forth that the company has assets amounting to $11,600, consisting of $600 in cash and $11,000 in bills receivable. The directors of the company are: S. V. Mooney, John H. Miller, J. A. Stephens and A. A. Roe.

ILLUMINATION.

Porterville, Cal.—At a special meeting of the City Trustees a resolution was passed granting A. Genslein, or his assignors, permission to law gas pipes and connections upon all public streets and alleys of the city of Porterville, for the purpose of supplying the city with gas and electric light. Mr. Genslein represents the Southern California Gas Circuit Company. The company agrees to furnish gas at the rate of $1.50 per 1000 cubic feet for a period of five years. Work will be commenced next week obtaining contracts for furnishing gas.

San Jacinto, Cal.—The Hemet-San Jacinto Gas Company will begin work on a plant within thirty days. The offices of the company are in Hemet and San Jacinto.

City of Mexico, Mex.—A concession for a gas plant in Parral, Chihuahua, for the manufacture of gas for heating, lighting and power purposes has been obtained in the state capital by A. N. Degerra and James M. Hardy. Victor Esperon of Parral, R. Keays of El Paso and Dr. H. E. Thompson of St. Louis.

ILLUMINATION.

Merced, Cal.—A movement is under way here to secure a municipal electric light plant. The town trustees will be asked to call a bond election to vote on an issue of $40,000 in bonds.

San Leandro, Cal.—The Suburban Electric Light Company has been arranging for the past month for the extension of its gas system. The $50,000 necessary for the work has been appropriated by the stockholders, and the extension will be proceeded with as soon as possible.

Bisbee, Ariz.—An ordinance has been adopted granting to the International Gas Light Company a franchise to maintain an electric light and power system, and to build pole lines and conduits in Bisbee, Arizona.

Redding, Cal.—The plant of the Redding Gas Company, owned by the Northern California Power Company, is to be enlarged by the addition of a new gas holder. The addition will double the capacity of the plant.

Redondo, Cal.—At a meeting of the Board of City Trustees a communication was received from the Pacific Electric and Power Company requesting the Board to call for bids for a franchise for fifty years for supplying electricity for heat, light and power. Referred to City Attorney to take up with the company. The company has now in course of construction a power plant estimated to cost $1,125,000.

Carlsbad, New Mexico.—The citizens of Carlsbad have granted a gas franchise to A. J. Muzzy and his Eastern associates, and they state the plant will be in operation within the next twelve months. The company is also making large improvements in the water works system, and is arranging to extend the telephone system all over the country to the most distant ranches on the Texan side. Contracts are being made to furnish power to farmers for motors and for pumping and irrigation plants.

Long Beach.—The formation of a new gas company and the establishment of an ice and cold storage plant for Alamitos are rumored.

Palo Alto, Cal.—An ordinance requiring the California Gas and Electric Corporation to remove the main transmission line from University avenue, south of Cowper street, and permitting the erection of a new line of poles on Cowper, Forest, Ramona, Addison, Alma and Embareadero road, has been passed on second reading.

Elsinore, Cal.—Mr. Dunn, of the Home Telephone Co., proposed to the Trustees that upon completion of the electric light plant the city buy it at cost price, about $10,000. Mr. Dunn stated that he would accept bonds. The Board formed a Committee of the whole to consider the matter.

Avalon, Cal.—The old restaurant or hotel building is being moved down towards the water front and a large number of cottages are to be built, one hundred rumor says, and it is also reported that an electric lighting plant is contemplated.

Oroville, Cal.—At a meeting of the Board of Trustees, Manager Durbrow of the Oroville Water Company appeared before the board at its request and made a proposition to furnish 100 street lights to the city at the rate of $1.10 for each 32-candlepower incandescent light per month and $8 a month for each arc light.

Prescott, Ariz.—All machinery and equipment for the installing of a complete municipal electric light plant will be ordered at once. Superintendent Glass has been instructed to purchase all supplies as per a report submitted by him at the meeting of the Council, on which bids weer opened. To John A. Roebling Sons Co., bid on copper wire accepted, $2000 worth ordered; to Westinghouse Co., three-phase generator, equipped with exciter and switchboard, and supplies, $2324; to Wesco Supply Company, bid on twenty-five arc lamps, one regulator and switchboard, $767 f. o. b. Prescott and patr of supplies ordered.

POWER AND LIGHT PLANTS.

Arlington, Wash.—The Jim Creek dam has been destroyed. The power plant was to have been completed December 1st. It will take until March to reconstruct the dam.

Edmonds, Wash.—The Skyomish Light & Power Co. has been granted two franchises, one for an electric road and one for an electric lighting system for this place.

Portland, Ore.—The Western Electric Co. has been incorporated by Charles H. Carey, Omar C. Spencer and Roger B. Sinnott; capital, $50,000.

Spokane, Wash.—An electric motor that will extract electricity from the air without the aid of an intermediate agent is the invention of a Spokane man, represented by Albert Birch of Hillyard, and M. H. De Huff of this city.

Tacoma, Wash.—H. J. Cross, a representative of C. C. Moore & Co., of New York, is in the city seeking data in regard to the power plant which the city proposes to build.

Wallace, Ida.—A 350-horsepower engine has just been installed at the electric light plant by the Wallace Light & Water Co. The engine is fitted with a jet condenser and heater.

Yerington, Nev.—W. C. Orem, Mr. Pearce and J. J. Corum have arrived here to inspect the Nevada-Douglas property in which they are interested. This company has arranged to install electric power and put in a large air compressor. Work has begun on the extending of the power line from Como to this property and will be finished at an early date.

Santa Rosa, Cal.—Sealed bids are being received by the Council in this city for the franchise applied for by the Pacific Gas and Electric Company for a right-of-way for an electric transmission system along the public highways, streets and alleys of this city.

Meadows, Idaho. —C. W. Duck, engineer of Idaho City, is making surveys for an electric power plant which is to be erected here.

Rawlins, Wyo.—The Rawlins Electric Co. is contemplating the reconstruction of its system in this city. A new powerhouse will be built and new machinery and boilers will be installed.

Grinnell Automatic Fire Sprinkler...

Indorsed by all Fire Insurance Companies
Rates reduced 33⅓ to 50 per cent . . . .
50,000 buildings throughout the United States are equipped with the Grinnells
Recognized as the only perfect system of fire protection . . . . . .

Pacific Fire Extinguisher Company

145-153 Howard Street SAN FRANCISCO | 504-505 McKay Bldg. PORTLAND | 455-56 Colman Bldg. SEATTLE

Guarantee Electric Works

MOTORS SOLD and RENTED
Expert Repairing, Dynamos, Motors
Transformers, Anything Electrical

Big Bargains in Second Hand Motors
Remember we guarantee Everything....Come and see.

218 Eighth St. Bet. Howard and Folsom

CHARLES PFLUGER, Mgr. Telephone Market 2146